GLASGOW METEOROLOGY AND AIR QUALITY ANALYSIS REPORT

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GLASGOW
METEOROLOGY AND
AIR QUALITY
ANALYSIS REPORT

Prepared by

Environmental Division
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TABLE OF CONTENTS

CONTENTS PAGE

Glasgow Meteorology and Air Quality Analysis Report

I. INTRODUCTION

In September 1977, the Montana Energy and MHD Research and Development Institute (MERDI) installed a 100-meter meteorological tower at Glasgow Air Force Base (GAFB), Montana. The purpose of the tower is to establish the solar and wind energy potential and the atmospheric dispersion potential of that northeastern Montana area. The tower is equipped with sensors at three levels: ten meters, 31.6 meters, and 100 meters. The tower is located at GAFB (about 20 miles north of Glasgow, Montana) at an elevation of 827 meters.

This report presents wind energy, solar energy, and pollution dispersion data obtained from the GAFB meteorological tower between October 25, 1977 and August 31, 1978 as well as background meteorological and air quality data. In addition, it compares data collected from GAFB with data obtained from the Glasgow National Weather Service (NWS) between October 25, 1977 and June 30, 1978. Data collected during this time period also is compared with historical Glasgow NWS data.

II. WIND SPEED CHARACTERISTICS

One possible re-use for the air base is an electrical generation center utilizing wind-powered generators. Therefore, it is necessary to establish average wind speeds, most frequently observed wind speeds, and other statistics to determine the feasibility of wind-powered electricity generation.

A. Monthly Wind Speed Averages

Figures 1A through 1C show monthly wind speed averages at the 10-meter, 31.6-meter, and 100-meter levels, respectively. The dotted lines represent standard deviations for each month. These figures illustrate the high month-

Figure 1A.--Average Monthly Wind Speeds
Ten-Meter Level

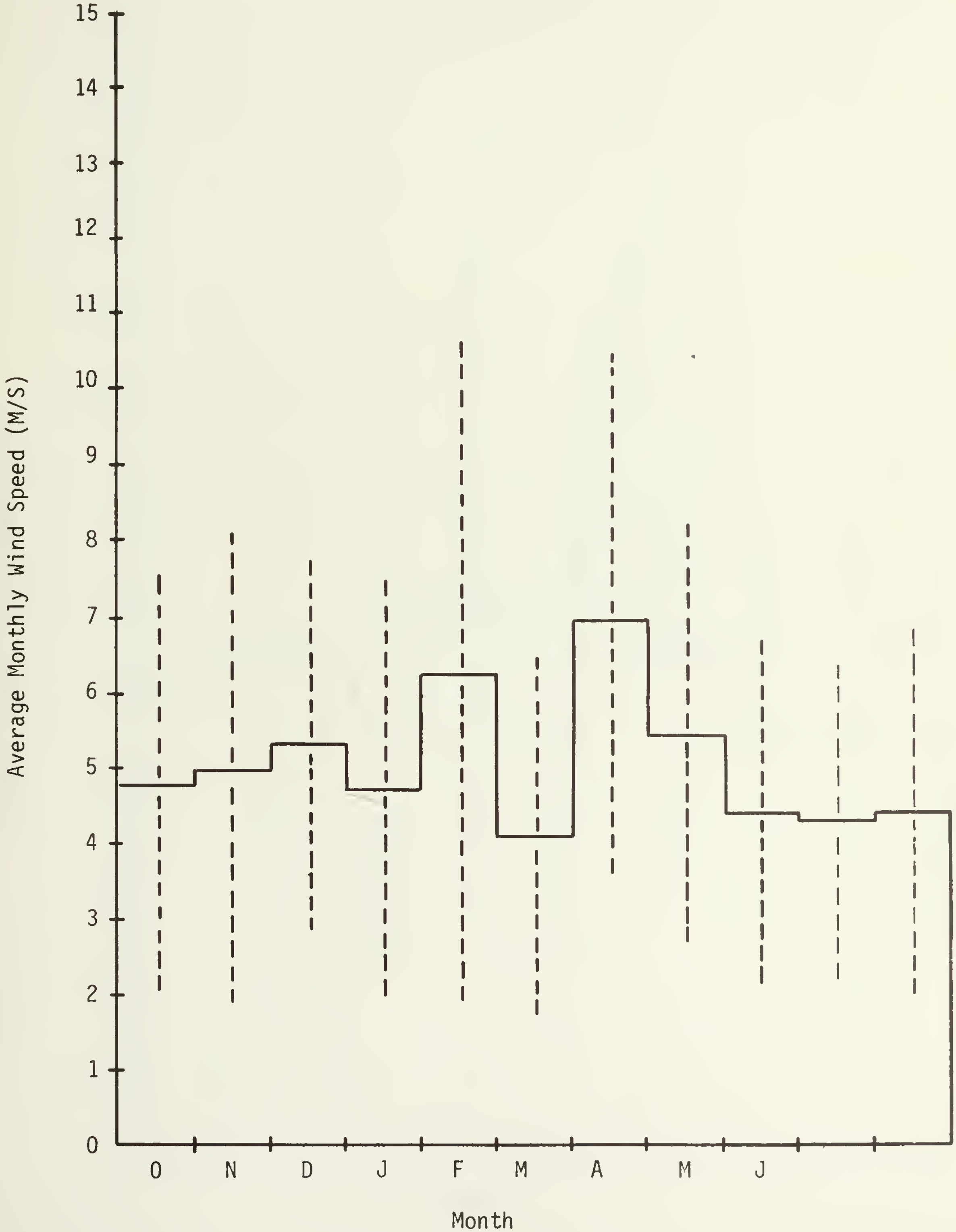


Figure 1B.--Average Monthly Wind Speeds
31.6-Meter Level

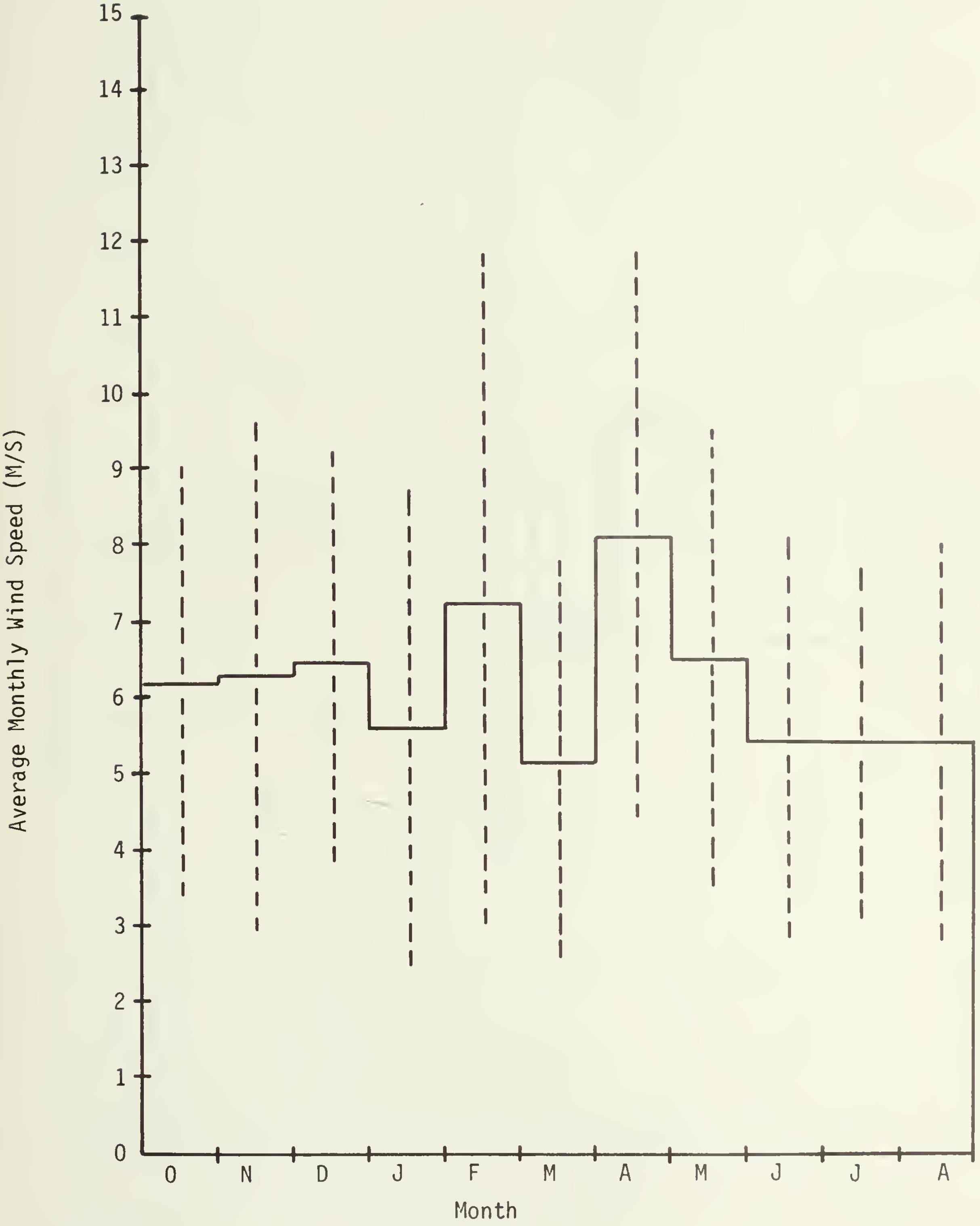
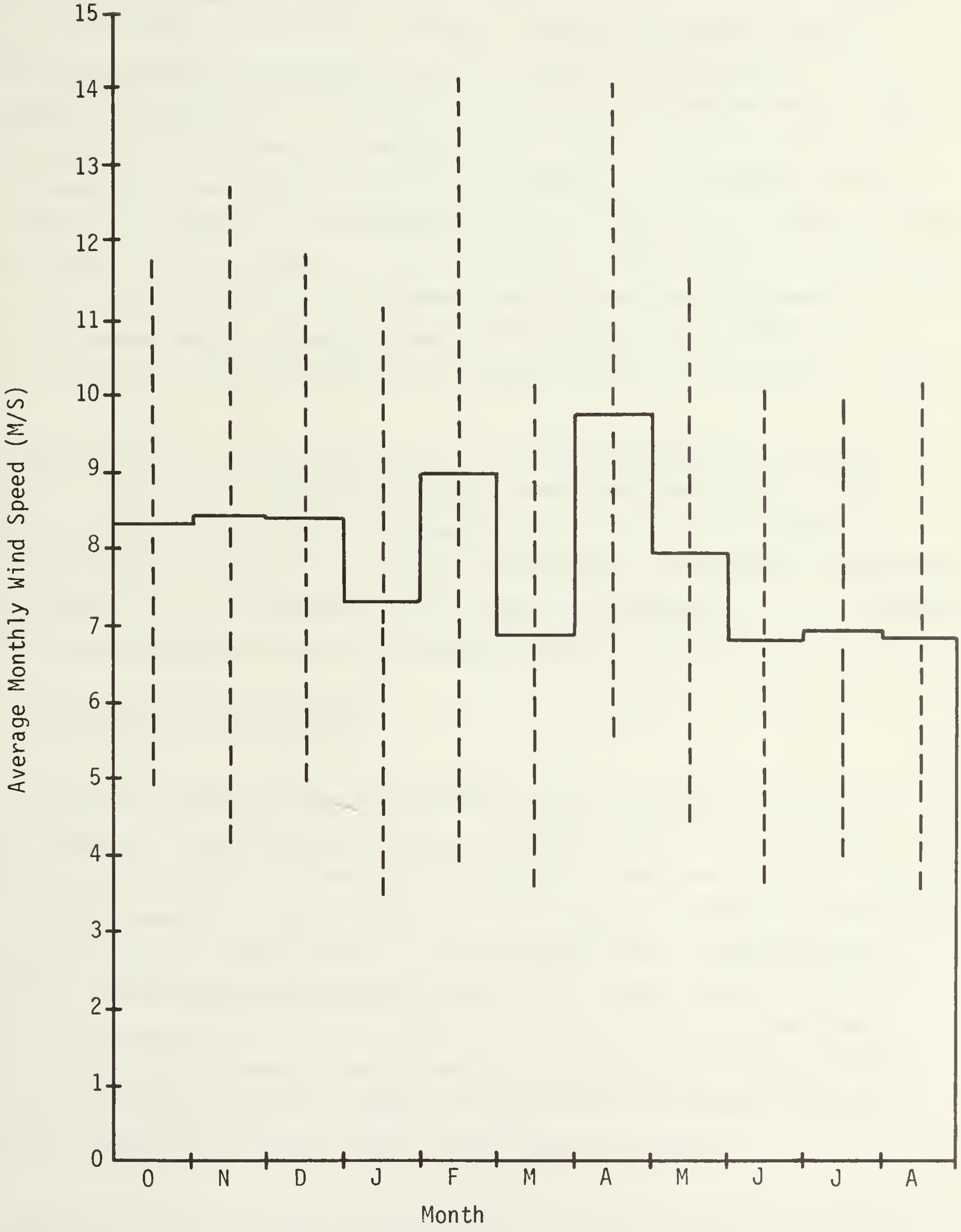


Figure 1C.--Average Monthly Wind Speeds
100-Meter Level



to-month wind speed variation, as well as the high wind speed variability within each month. Wind speeds at the ten-meter level averaged 5.1 ms^{-1} during this study; however, Figure 1A indicates monthly speed averages ranging from 4.1 ms^{-1} in March to 6.9 ms^{-1} in April. Monthly wind speed standard deviations were generally between 2 and 3 ms^{-1} implying high monthly variability. An average wind speed of 6.2 ms^{-1} was observed at the 31.6-meter level; Figure 1B indicates monthly speed averages ranging from 5.2 ms^{-1} in March to 8.2 ms^{-1} in April, showing the same monthly variability observed at the ten-meter level. The average wind speed at the 100-meter level was 7.8 ms^{-1}, with monthly averages ranging from 6.7 ms^{-1} in June to 9.7 ms^{-1} in April. Note that wind speeds at all three levels show the same month-to-month trends; wind speeds decrease markedly during the summer months. Monthly speed standard deviations increase somewhat with height, indicating higher wind speed variability at the higher levels.

Day-to-day wind speed variability is even more pronounced, as shown in Figure 1D. Note that during November, daily wind speed averages at the ten-meter level ranged from 1.3 ms^{-1} on November 28 to 9.7 ms^{-1} on November 2. Daily wind speed variability also varies considerably, with standard deviations ranging from 0.9 ms^{-1} on November 18 to 4.8 ms^{-1} on November 26. This indicates fairly constant winds on some days and highly variable winds on others.

B. Distribution of Wind Speeds

Average wind speeds give an indication of the available wind power in an area; however, that information alone is insufficient. In wind energy determinations, it also is important to know which wind speeds are most common (i.e., which speeds will supply most of the wind power). Figure 2A shows the wind speed frequency distribution for the ten-meter level; speeds between 3 and 4 ms^{-1} were the most common, while each 1 ms^{-1} speed interval between 2 and 6 ms^{-1} accounted for over ten percent of the observations. Note that the most frequently observed speed intervals are below the average speed of 5.1 ms^{-1}, indicating that this average resulted from many winds just below the average speed and a scattering of winds above that speed.

Figure 2B shows the wind speed frequency distribution for the 31.6-meter level, where the average speed was 6.2 ms^{-1}. Note that each 1 ms^{-1} speed

Figure 1D.--Daily Wind Speed Averages and Standard Deviations November 1977 Ten-Meter Level

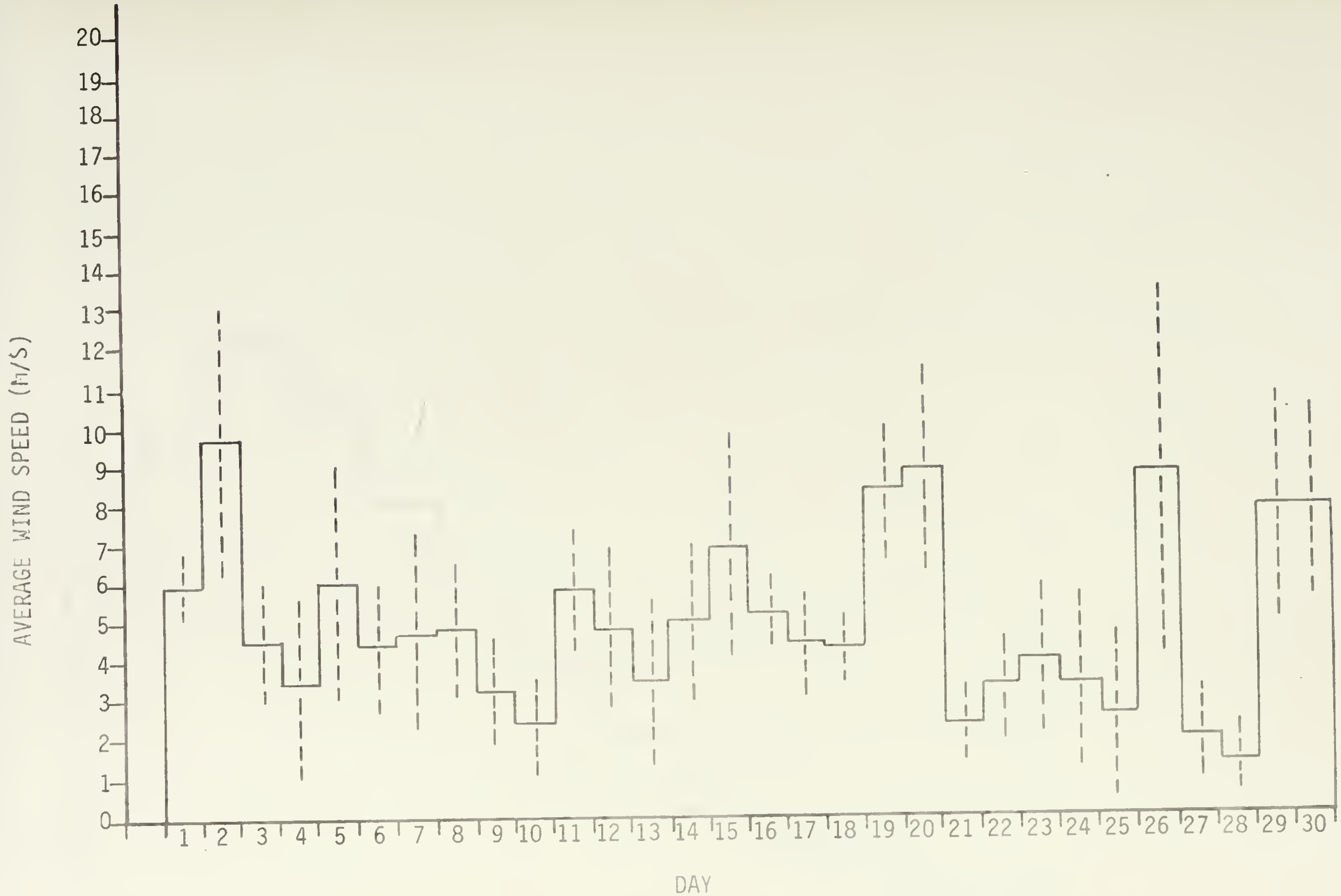


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Figure 2A.--Wind Speed Frequency Distribution Ten-Meter Level

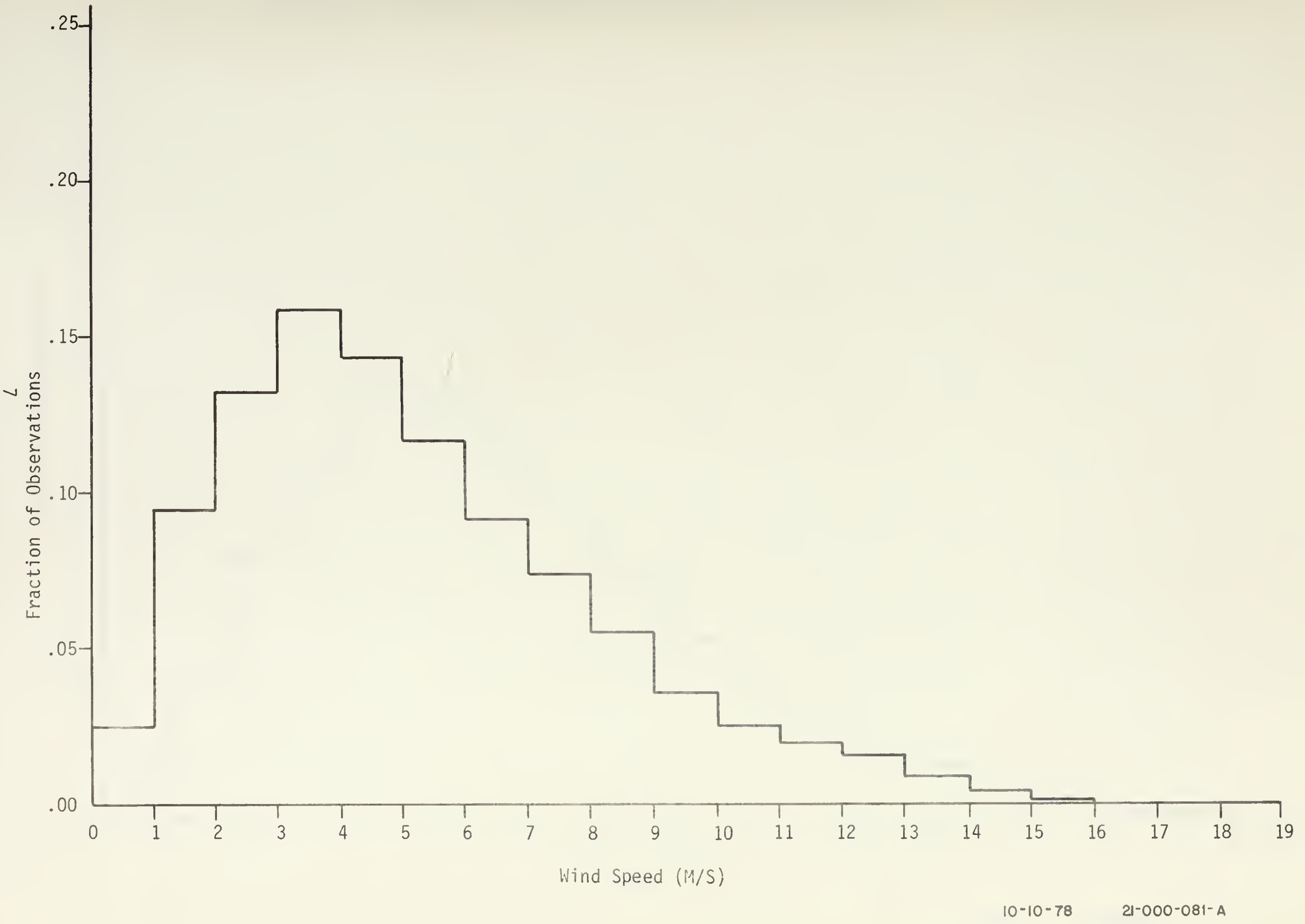
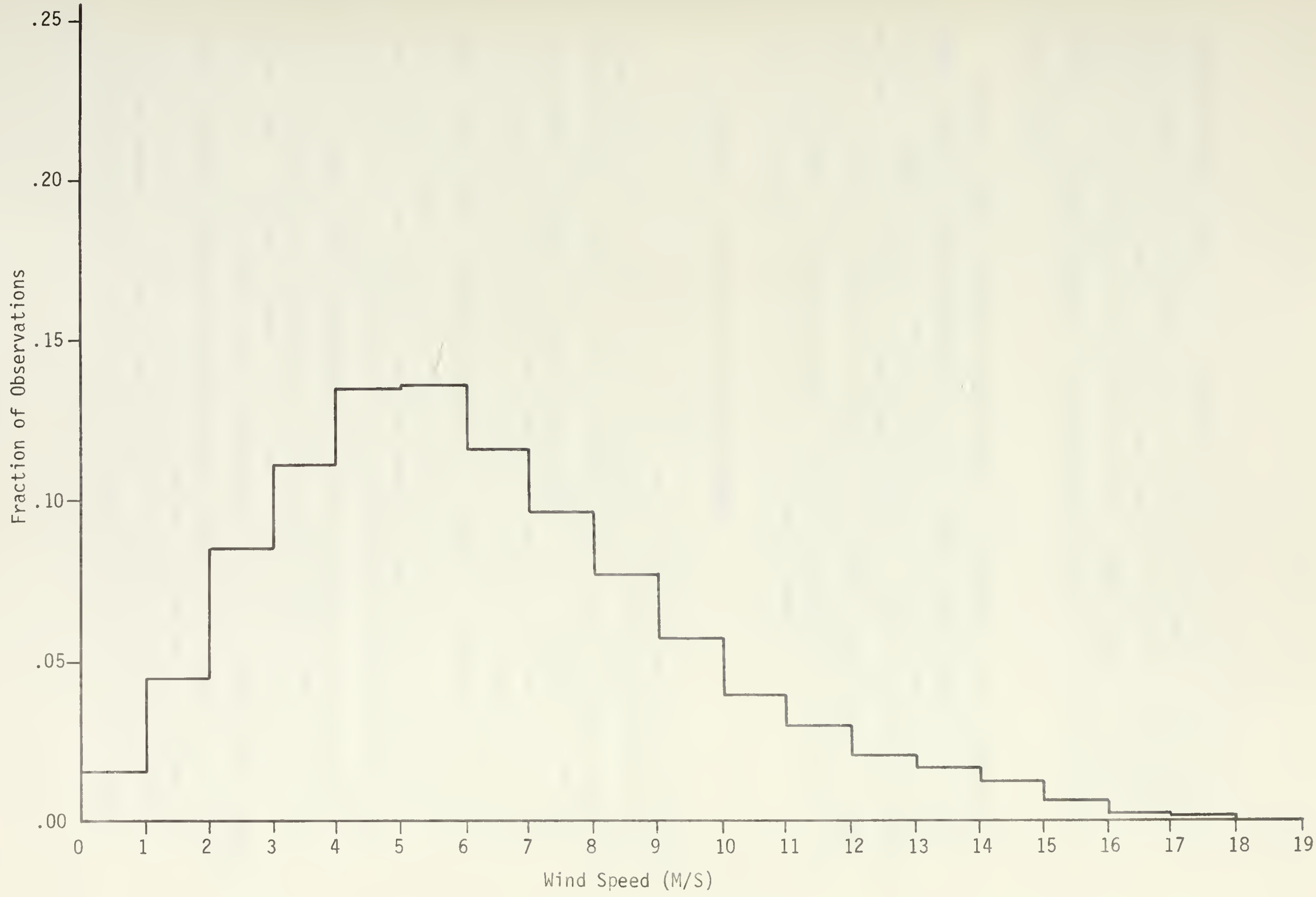


Figure 2B.--Wind Speed Frequency Distribution 31.6-Meter Level



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interval between 3 and 7 ms^{-1} accounted for over ten percent of the observations, while speeds between 5 and 6 ms^{-1} were most common. This suggests that speeds at 31.6 meters tend to be more centered about the average than speeds at the ten-meter level and that the most common speeds are closer to average. A greater variety of wind speeds was observed at 31.6 meters than at ten meters.

Figure 2C shows the wind speed frequency distribution for the 100-meter level, where the average speed was 7.8 ms^{-1}. Wind speeds between 6 and 7 ms^{-1} were most common; however, these accounted for only ten percent of the observations. This distribution closely approximates a normal distribution centered about the average, unlike the ten-meter and 31.6-meter distributions. Figure 2C also indicates higher wind speed variation; wind speeds are not concentrated within a few ranges, as at the ten- and 31.6-meter levels.

C. <u>Frequencies of Winds Below Certain Speeds</u>

In wind turbine design, two factors are of critical importance--the cut-in speed and the rated speed. The cut-in speed is the wind speed needed for the turbine to begin operation, while the rated speed is the wind speed needed for the turbine to operate at maximum power output. It is necessary to know how often the wind is below these two speeds; if the wind is below cut-in speed, the turbine cannot operate, and if the wind is below the rated speed, the turbine cannot operate at maximum efficiency. Consider a hypothetical turbine with a cut-in speed of 4 ms^{-1} and a rated speed of 12 ms^{-1}. Figure 3A shows the fraction of the time that the wind speed was below each of the speed categories at the ten-meter level. About 40 percent of the winds were below the cut-in speed, while 96 percent of the winds were below the rated speed. This indicates that the hypothetical turbine would operate poorly at the ten-meter level. Figure 3B shows this information for the 31.6-meter level. At this level, 25 percent of the winds were below cut-in speed while 94 percent were below the rated speed, indicating the turbine could operate for 15 percent of the time at this level. The rated speed was reached only six percent of the time however. At the 100-meter level, Figure 3C indicates that only 16 percent of the winds were below cut-in speed; the turbine could operate

Figure 2C.--Wind Speed Frequency Distribution 100-Meter Level

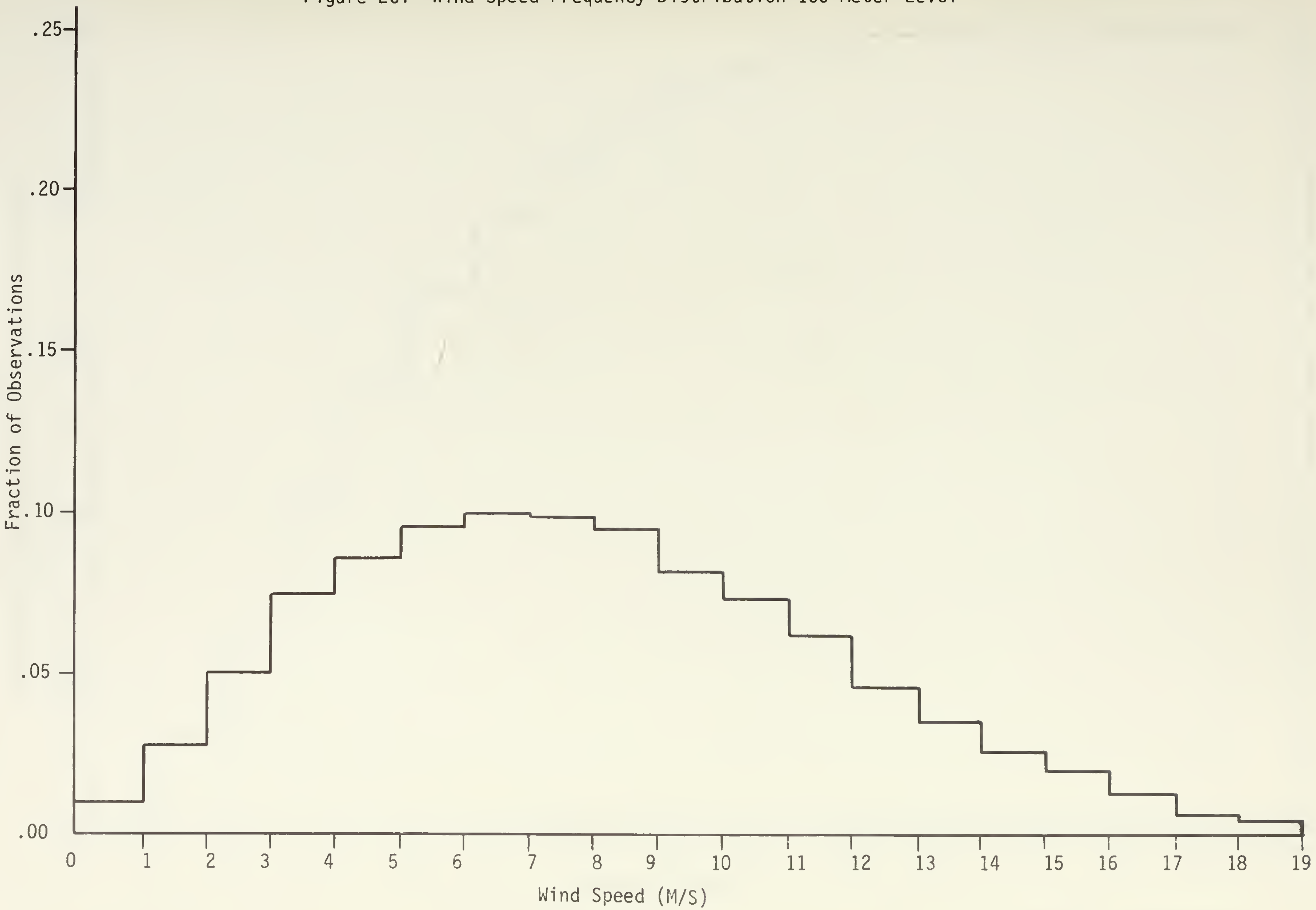

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Figure 3A.--Wind Speed Cumulative Fraction Ten-Meter Level

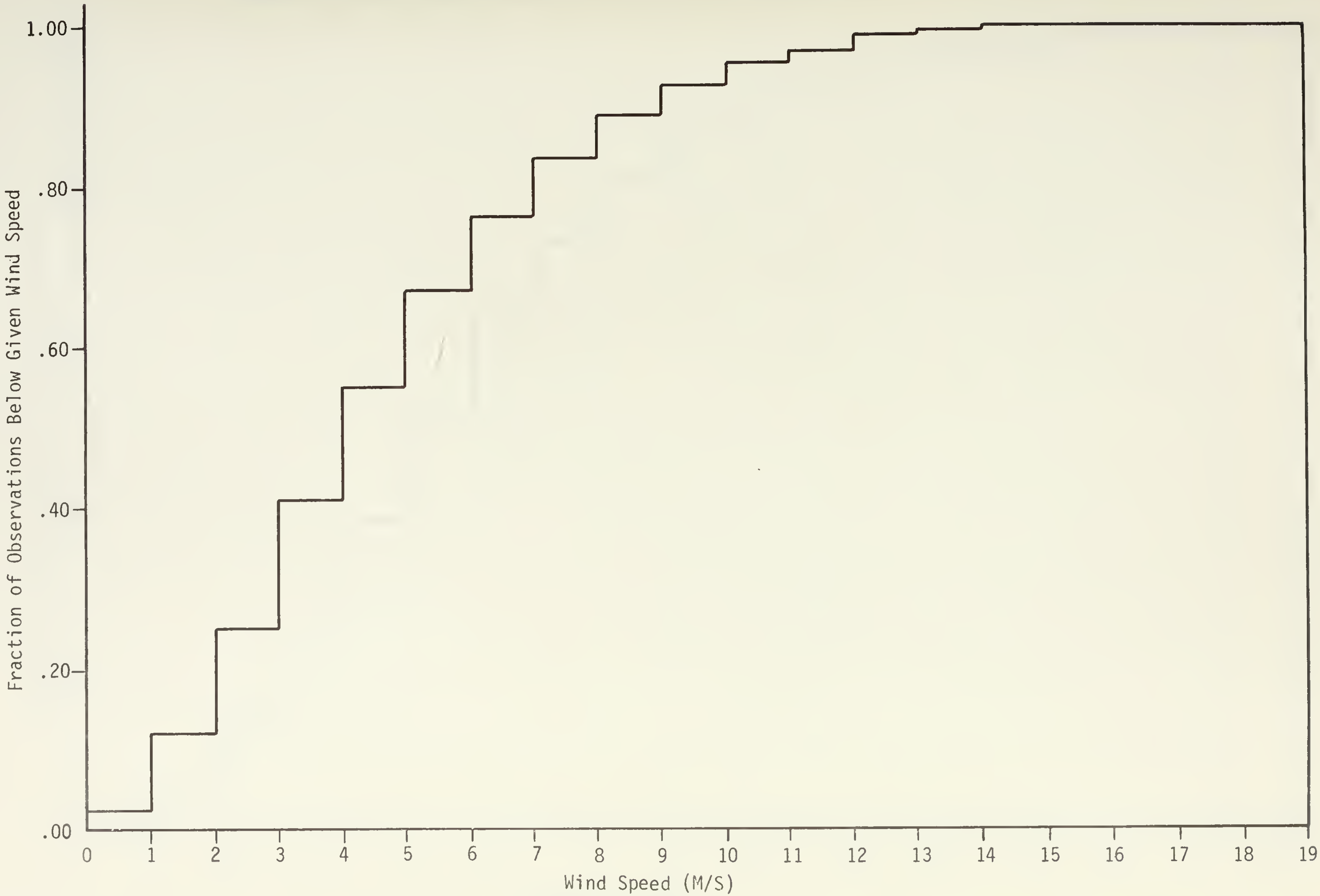

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Figure 3B.--Wind Speed Cumulative Fraction 31.6-Meter Level

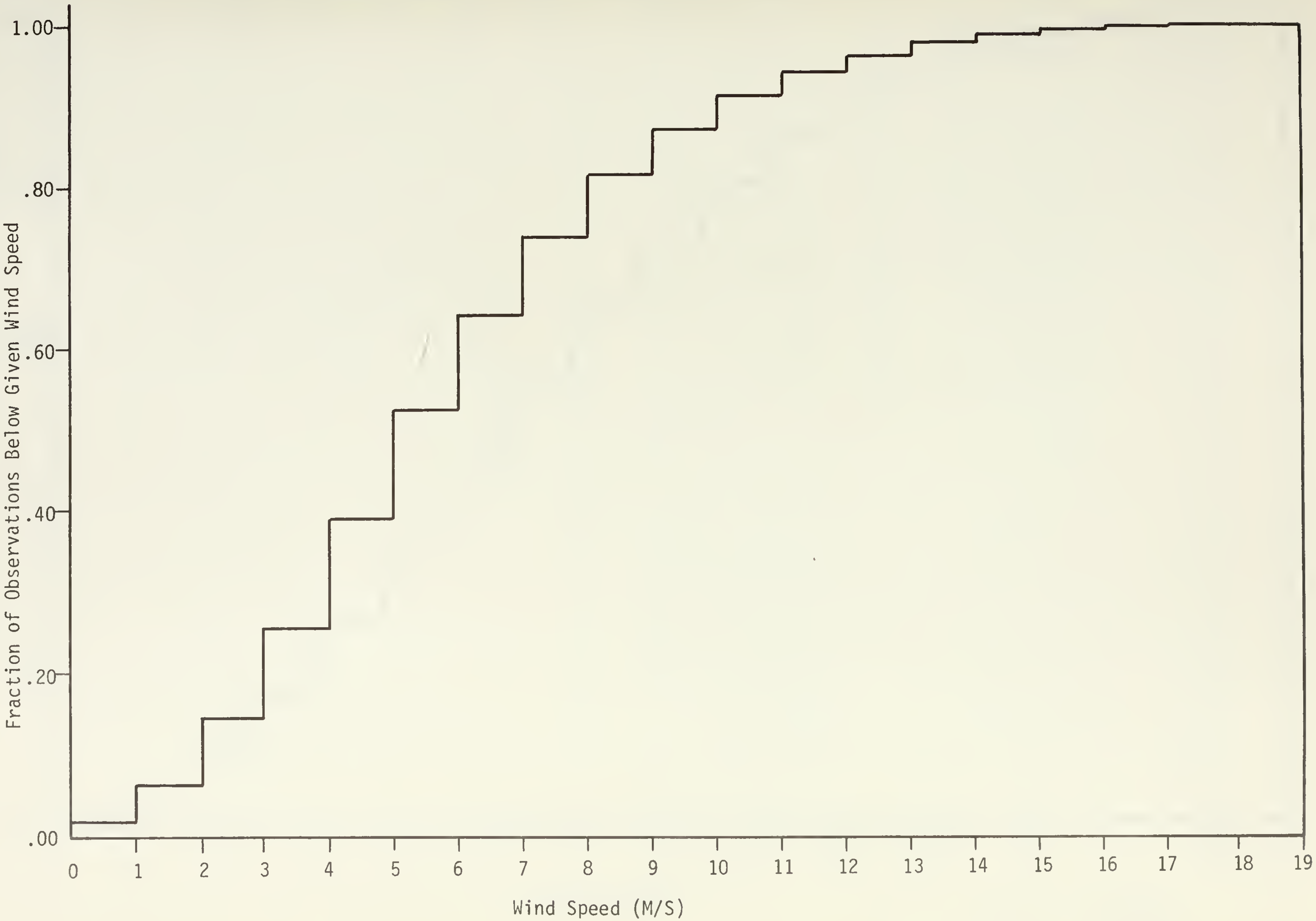

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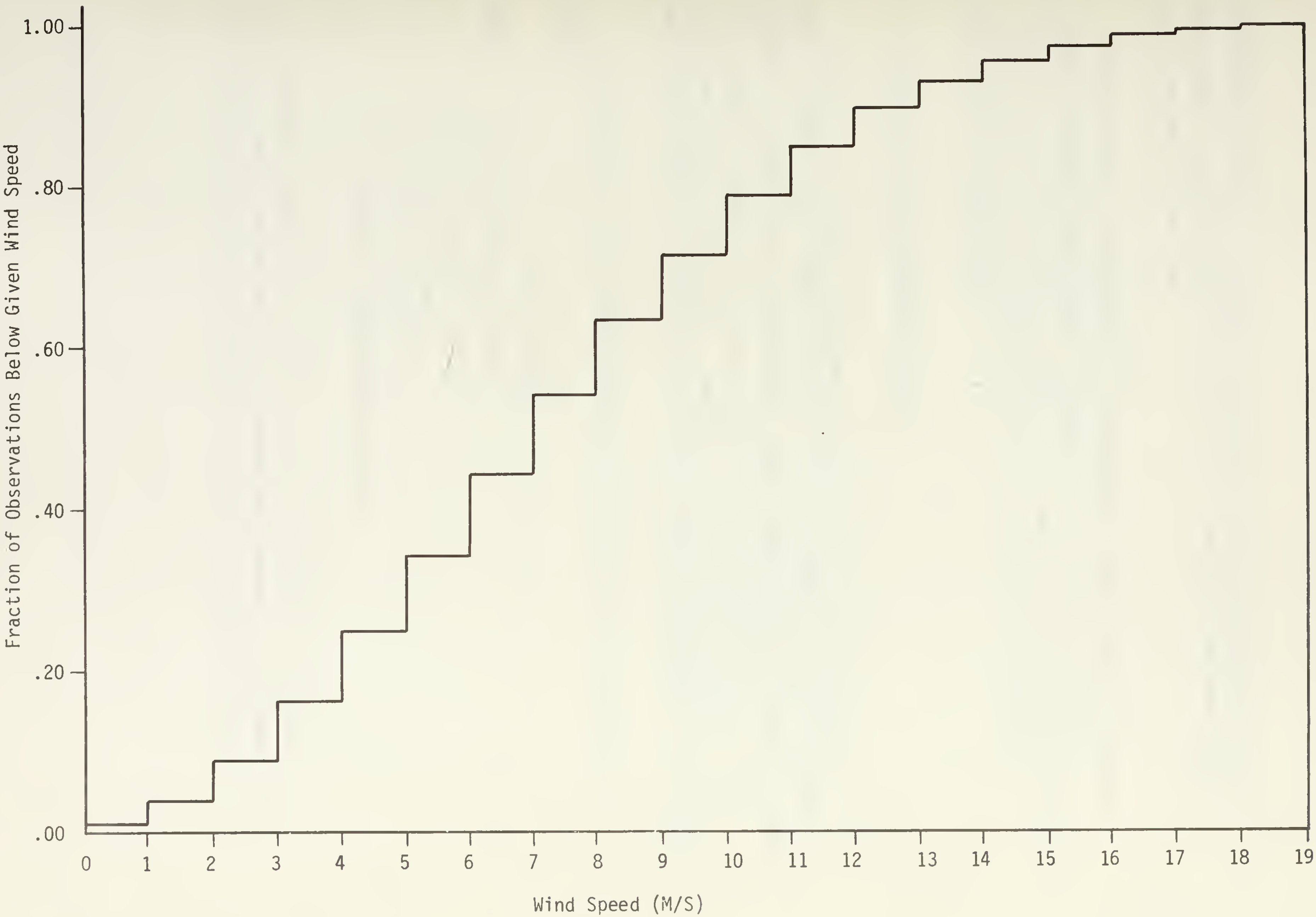
Figure 3C.--Wind Speed Cumulative Fraction 100-Meter Level



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84 percent of the time. However, 84 percent of the winds were below the rated speed, indicating that the turbine could operate at maximum output only 16 percent of the time.

These figures indicate that the turbine will operate more efficiently at greater heights above ground. However, the cost of wind turbine installation increases at greater heights above ground. The cost effectiveness of installation at greater heights should be examined, and an optimum height should be determined.

D. Increase of Wind Speed with Height

There are two reasons for examining the increase of wind speed with height at GAFB. One is the additional cost encountered in installing wind turbines at greater heights above the ground, necessitating the determination of an optimum installation height, which will be determined in part by the wind speed increase with height. Another reason is that the change of wind speed with height can influence the pollution dispersion potential of an area.

The increase of wind speed with height is described by a power law formula:

$$V_1 = V_0 \left(\frac{Z_1}{Z_0}\right)^P$$

where V_1 = wind speed at level 1,
V_0 = wind speed at level 0,
Z_1 = height of level 1,
Z_0 = height of level 0, and
P = empirically determined exponent.

Atmospheric stability is defined in terms of Pasquill stability categories, which are delineated by temperature changes in a 90-meter vertical cross-section of the atmosphere as shown in the following table.

Pasquill Stability Category	Type of Stratification	Temperature Change in a 90-meter Section ($T_{100 \text{ meters}} - T_{10 \text{ meters}}$)
A	Very unstable	<-1.7°C
B	Moderately unstable	-1.7 to -1.5°C
C	Slightly unstable	-1.5 to -1.3°C
D	Neutral	-1.3 to -0.4°C
E	Slightly stable	-0.4 to 1.3°C
F	Moderately stable	1.3 to 3.6°C
G	Very stable	>3.6°C

Figure 4 describes the wind speed increase with height (hereafter termed "P-value") as a function of atmospheric stability. The dotted lines represent standard deviations of these P-values, indicated by the distances these lines extend above and below the means. For neutral and unstable cases, P-values are nearly equal, averaging around .100. P-values increase markedly during stable stratifications, however, ranging from .226 during category E conditions up to .400 during category G conditions. Note that P-values are quite variable during all temperature stratifications and especially during category G conditions.

Figure 5A and 5B indicate P-values as a function of both atmospheric stability and the near-surface wind direction. Wind directions are categorized by 30° intervals; for example, the direction labeled 210 includes all wind directions between 195° and 224°. P-values for stability categories D and E show little directional dependence; as in Figure 4, these P-values are highly variable. During category F conditions, however, a significant dependence of P-values on surface wind direction is observed; P-values range from .15 during northeasterly winds to .39 during southerly winds. Category G conditions exhibit an even greater directional dependence; P-values increase from .08 during northerly winds up to .48 during southwesterly winds. This may help explain why in Figure 4 higher P-value variability was observed during category G conditions than for other cases. The higher variability of P-values during category G conditions is less pronounced when the P-values are analyzed as a function of surface wind direction.

Figure 4.--100-Meter - 10-Meter
P-Values For Pasquill Stability Categories

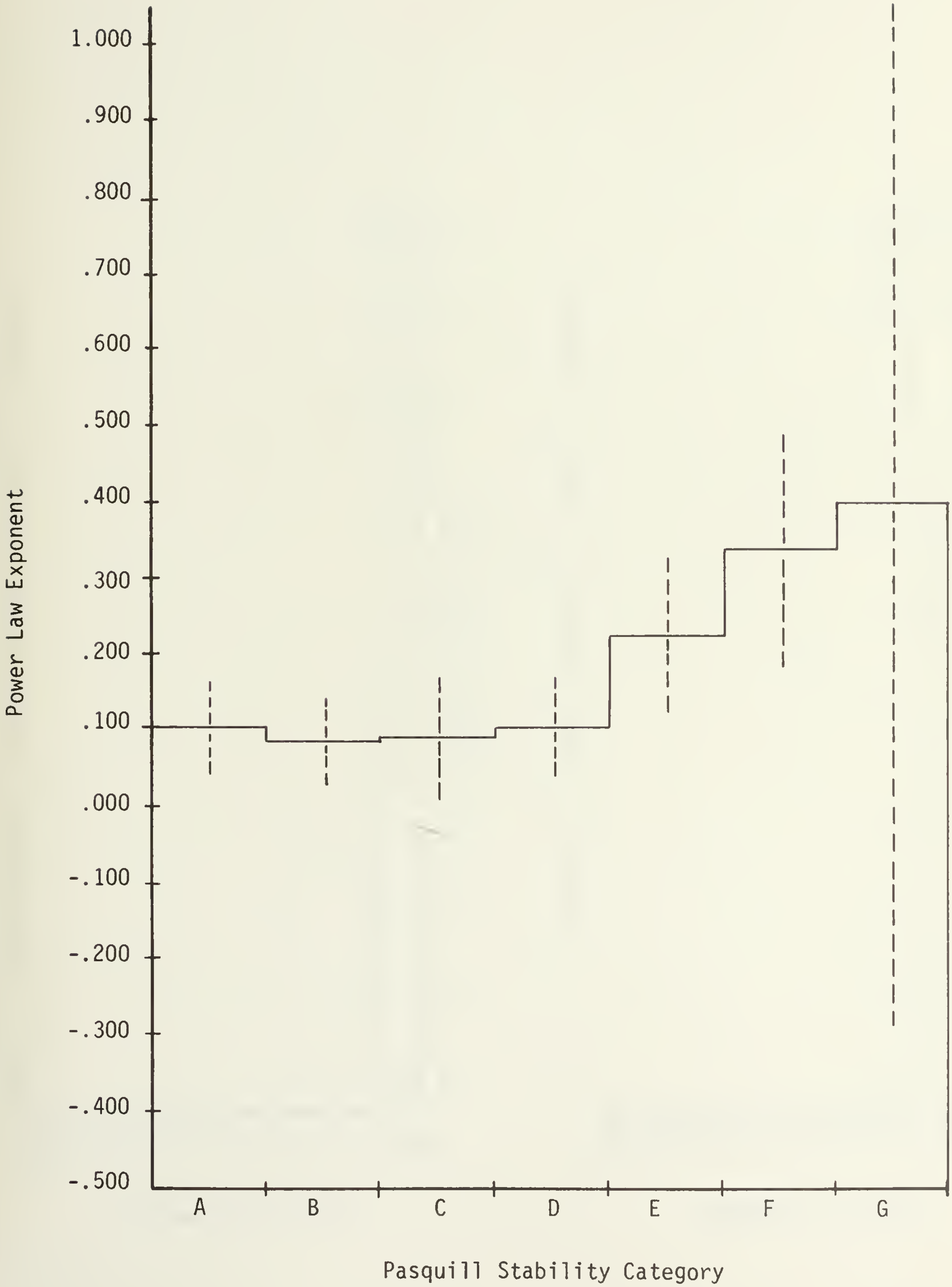
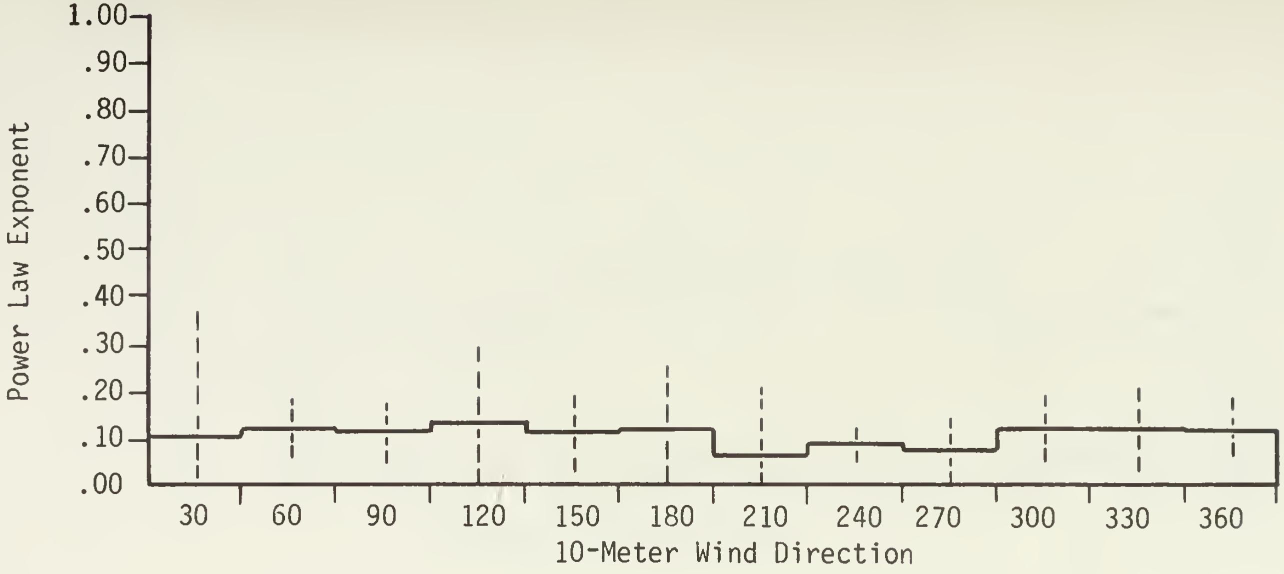


Figure 5A.--Directional P-Values for Pasquill Stability Category D



Directional P-Values for Pasquill Stability Category E

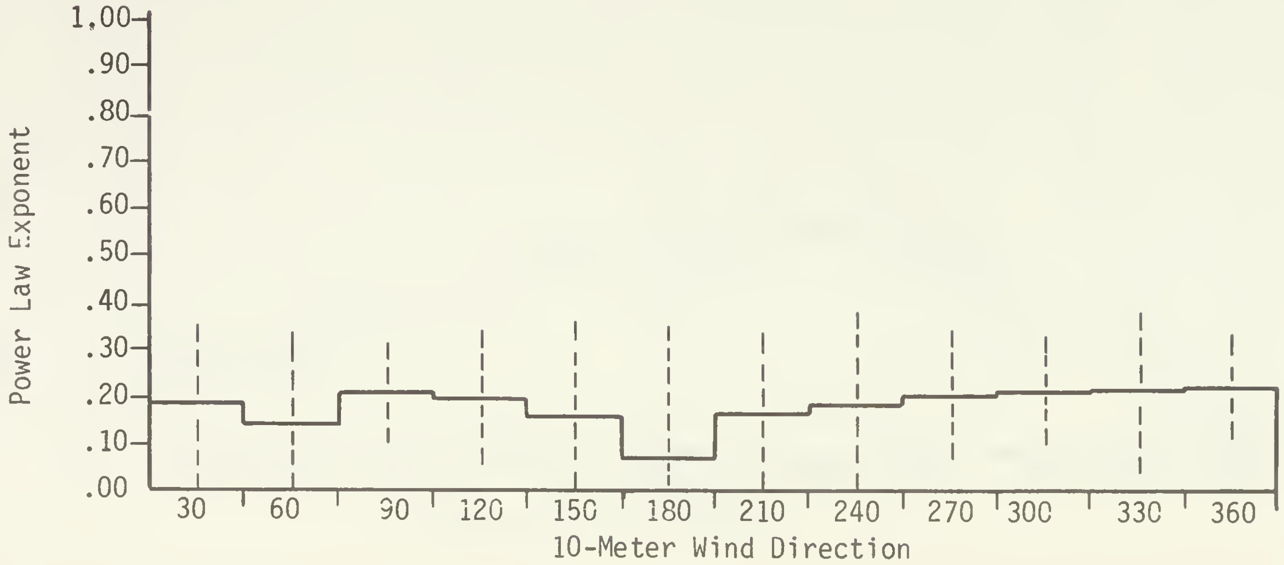
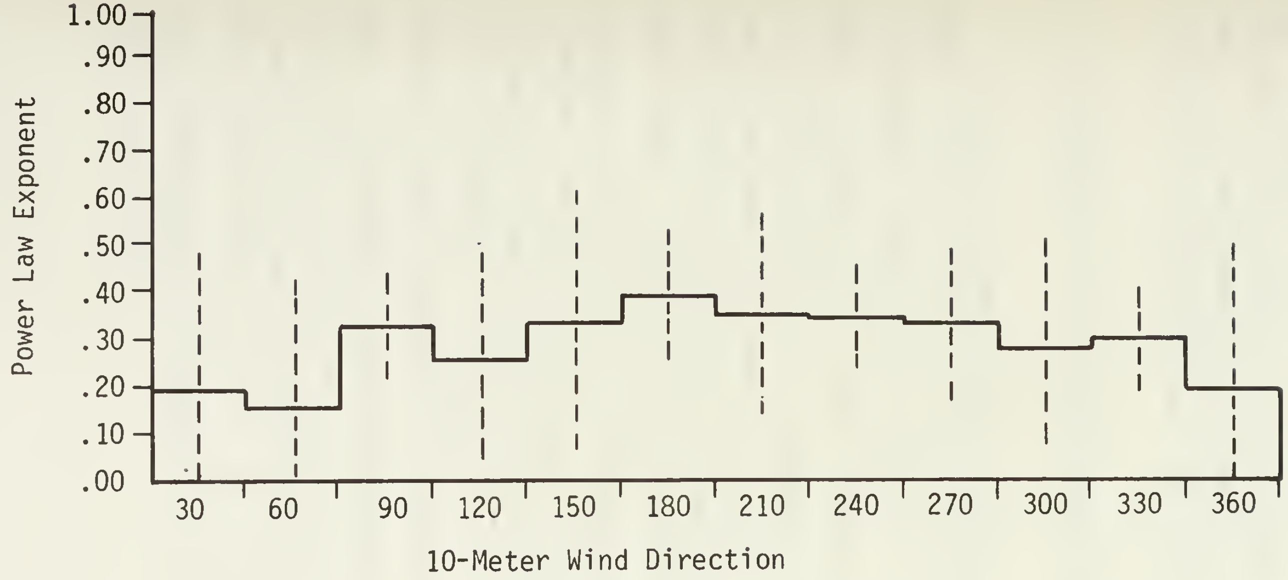
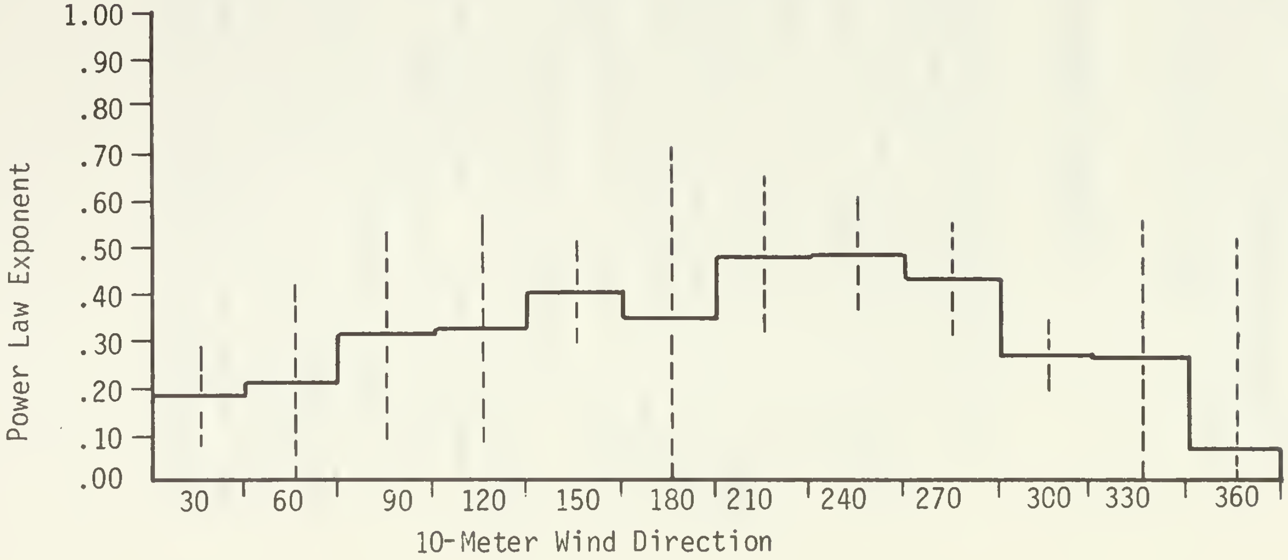


Figure 5B.--Directional P-Values for Pasquill Stability Category F



Directional P-Values for Pasquill Stability Category G



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III. GLASGOW AREA DISPERSION CHARACTERISTICS

Another possible re-use of GAFB is a coal-fired power plant site; therefore, it is necessary to describe wind speed and direction patterns as well as atmospheric stability characteristics of that area. In addition, it is necessary to compare wind and stability data from GAFB with data collected by Glasgow NWS. This is desirable because many years of Glasgow NWS data are available, while the GAFB tower will collect only one year of data. A good comparison of data from these locations will justify the use of historic Glasgow NWS data to describe past conditions at GAFB.

A. Glasgow Air Force Base--Glasgow NWS Wind Speed Comparison

Figure 6A shows average wind speeds observed at GAFB when given wind speeds were observed at Glasgow NWS during daytime hours (0800-1700 MST). For example, when a wind speed of 4.1 ms^{-1} (8 knots) was observed at Glasgow NWS, the average wind speed at GAFB was 4.0 ms^{-1}. The standard deviation of the GAFB wind speed, indicated by the dotted line, was 1.6 ms^{-1}. This indicates some wind speed variability between the two locations for individual observations but great wind speed similarity over the long term in the 4 ms^{-1} speed range. Similar results were observed for all Glasgow NWS wind speeds between 3.1 and 9.7 ms^{-1}; an average speed difference of 0.5 ms^{-1} was never exceeded. However, significant wind speed differences were observed at Glasgow NWS speeds below 3.1 ms^{-1} (6 knots); it is suspected that this may be due to difference in instrumentation at the two locations. Figure 6B shows the wind speed comparison for nighttime hours (2000 to 0500 MST). In this case, wind speeds at GAFB were usually 0.5 to 1.0 ms^{-1} lower than speeds at Glasgow NWS; this difference was generally consistent. As in the daytime case, a possible instrumentation-related discrepancy was observed for Glasgow NWS wind speeds below 3.1 ms^{-1}. This analysis appears to support the use of long-term Glasgow NWS wind speed data for describing historical wind speed characteristics at GAFB.

Figure 6A.--Glasgow AFB Average Wind Speeds for Given Speeds at Glasgow NWS-Daytime

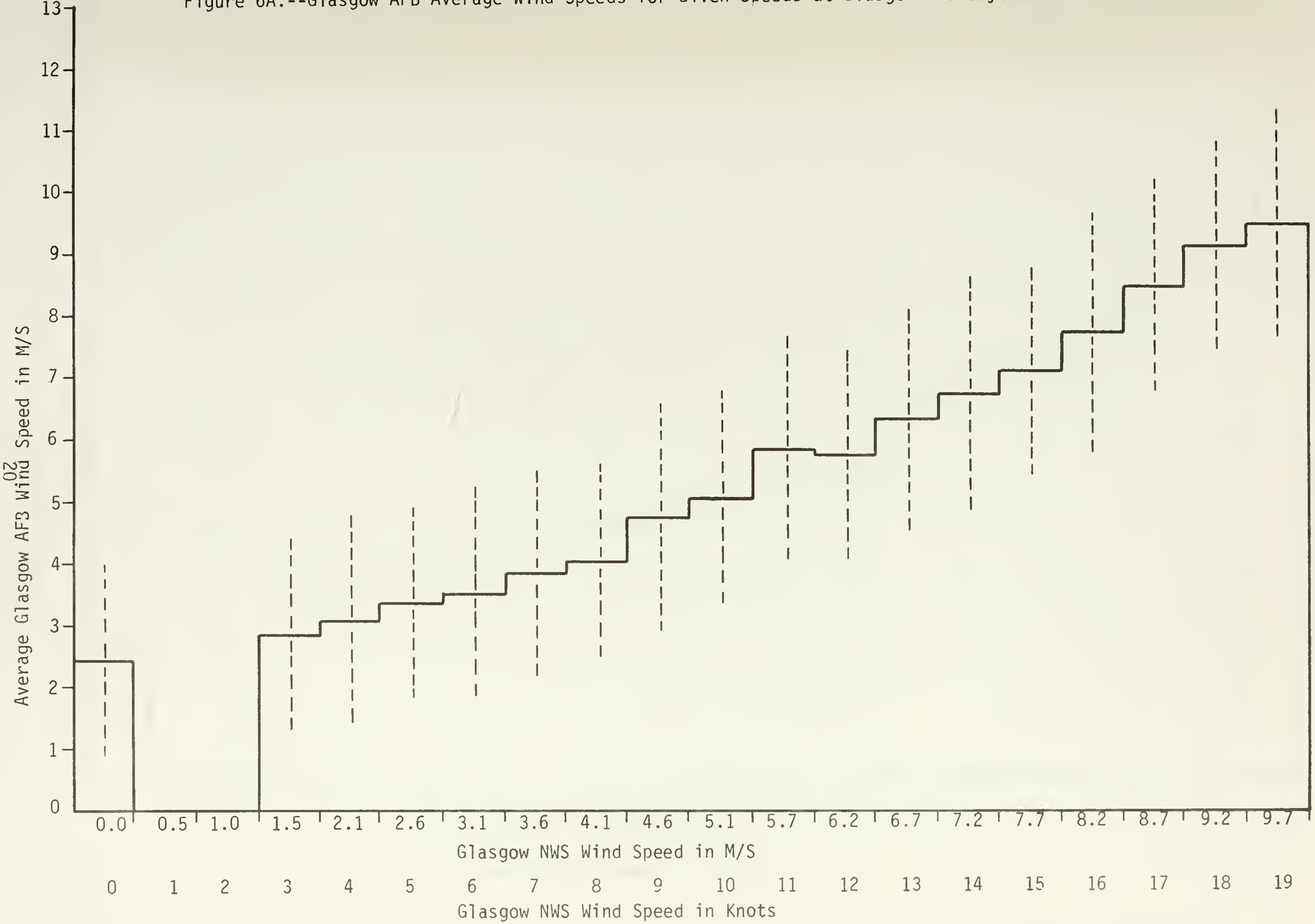

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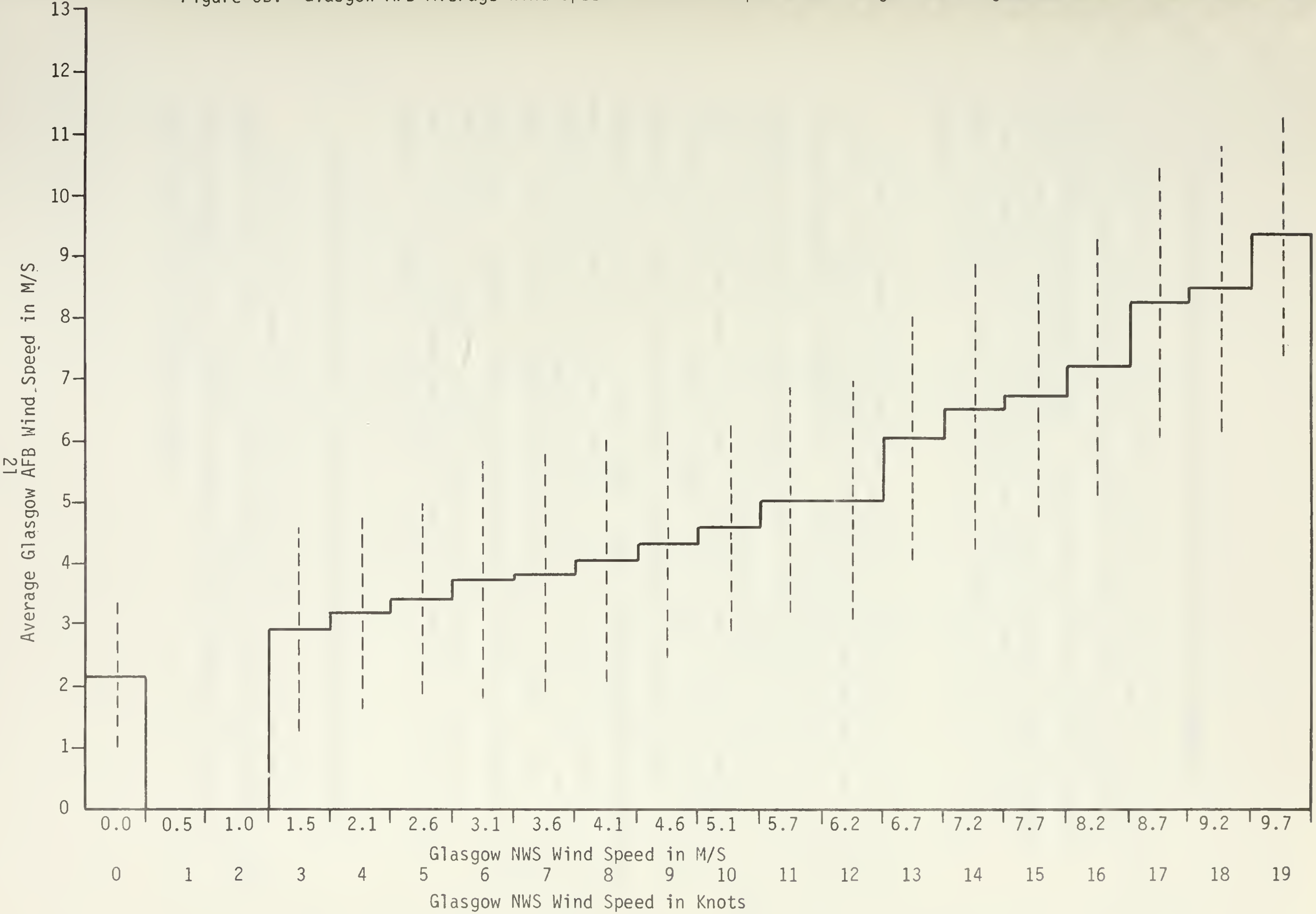
Figure 6B.--Glasgow AFB Average Wind Speeds for Given Speeds at Glasgow NWS - Nighttime



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B. Glasgow Air Force Base--Glasgow NWS Wind Direction Comparison

Figure 7A shows wind directions observed at GAFB when a wind direction of 110° (the most common wind direction at Glasgow NWS) was observed at Glasgow NWS during daytime hours. High wind direction similarity was observed between the two locations in this case; the most common GAFB wind direction was also 110°, which occurred about 28 percent of the time. Figure 7B indicates similar results during nighttime hours for this wind direction.

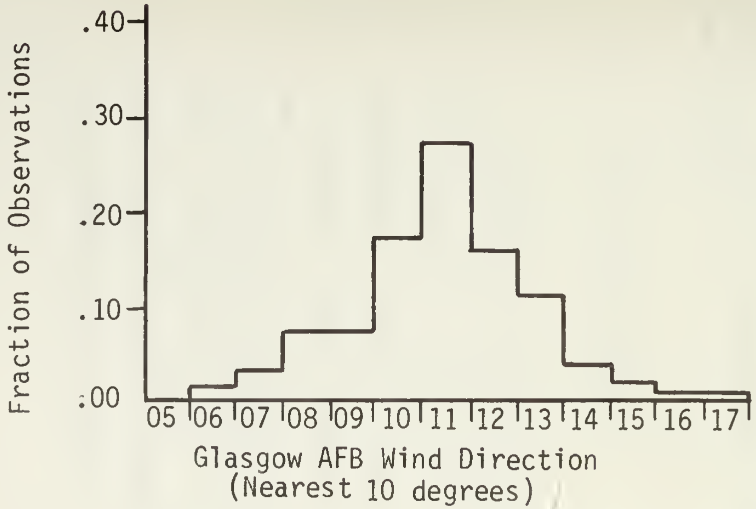
Figure 7C shows wind directions observed at GAFB when a wind direction of 320° (the second most common wind direction at Glasgow NWS) was observed at Glasgow NWS during daytime hours. Similar wind directions were observed at GAFB in this case; the most common GAFB wind direction, 310°, occurred 19 percent of the time, while 310° winds were observed 17 percent of the time. Figure 7D indicates good nighttime similarity as well; wind directions of 310° and 330° were most common at GAFB in this case. Similar results were observed for other wind directions for daytime and nighttime cases; the Glasgow NWS wind direction and the most commonly observed GAFB wind direction generally differed by no more than 30°. The only exceptions occurred during nighttime hours for Glasgow NWS wind directions of 130°, 140°, and 150°; in these cases, the most common GAFB wind directions were 190°, 200°, and 220°, respectively. However, these directions were observed at Glasgow NWS only three percent of the time. This analysis indicates that while there is some variability in individual wind direction observations for the two locations, the overall comparison is very good.

C. Comparison of Historical and 1977-1978 Wind Speeds at Glasgow NWS

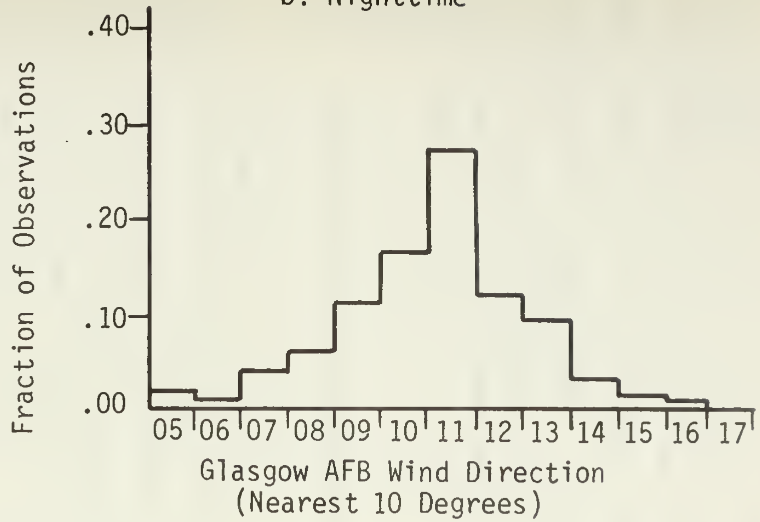
Section IIIA showed that wind speeds at GAFB and Glasgow NWS are generallly very similar. It is also desirable to compare 1977-1978 Glasgow NWS wind speeds with historical averages so that inferences can be made regarding 1977-1978 GAFB wind speeds.

Figure 7.--Observed Glasgcw AFB Wind Direction During a Direction of 110^{0} at Glasgow NWS

a. Daytime

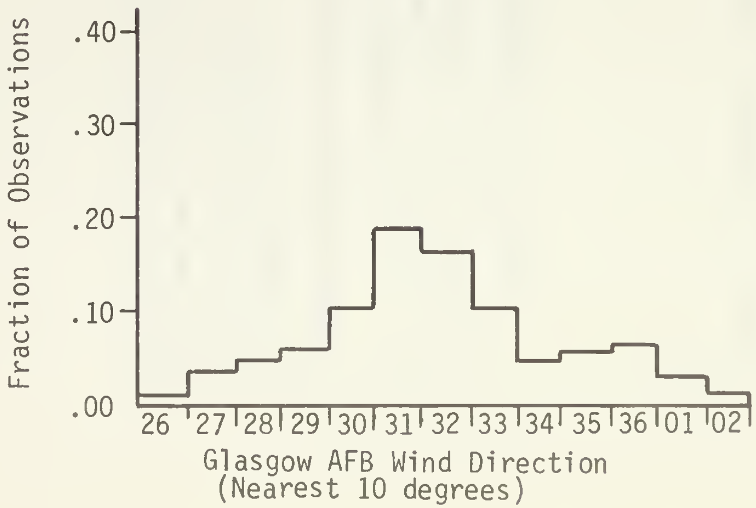


b. Nighttime



Observed Glasgow AFB Wind Direction During a Direction at 320^{0} at Glasgow NWS

c. Daytime



d. Nighttime

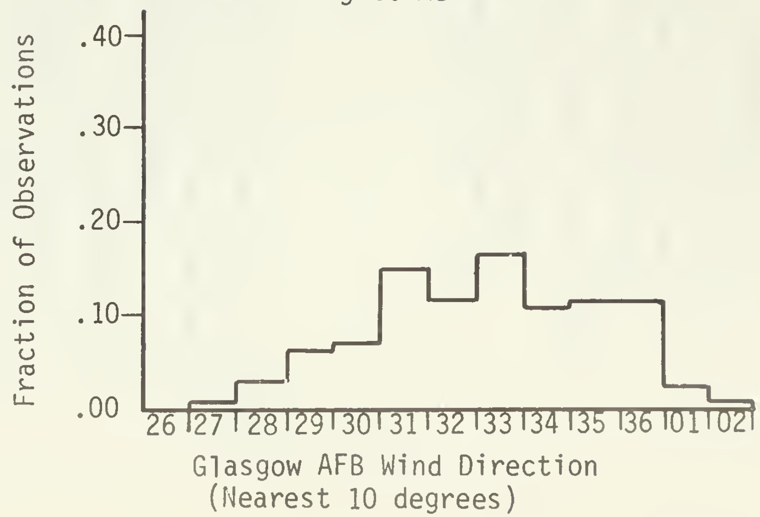


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Figure 8 shows monthly wind speed averages at Glasgow NWS during 1977-1978, as well as historical wind speed averages; it indicates that 1977-1978 was much windier than normal. Speeds during the study period were usually two to three knots above normal. February and April were exceptionally windy months. Only two months, March and June, had slightly below average wind speeds. This analysis indicates that wind speeds collected at the GAFB tower during this study are probably higher than what might be expected in a "normal" year.

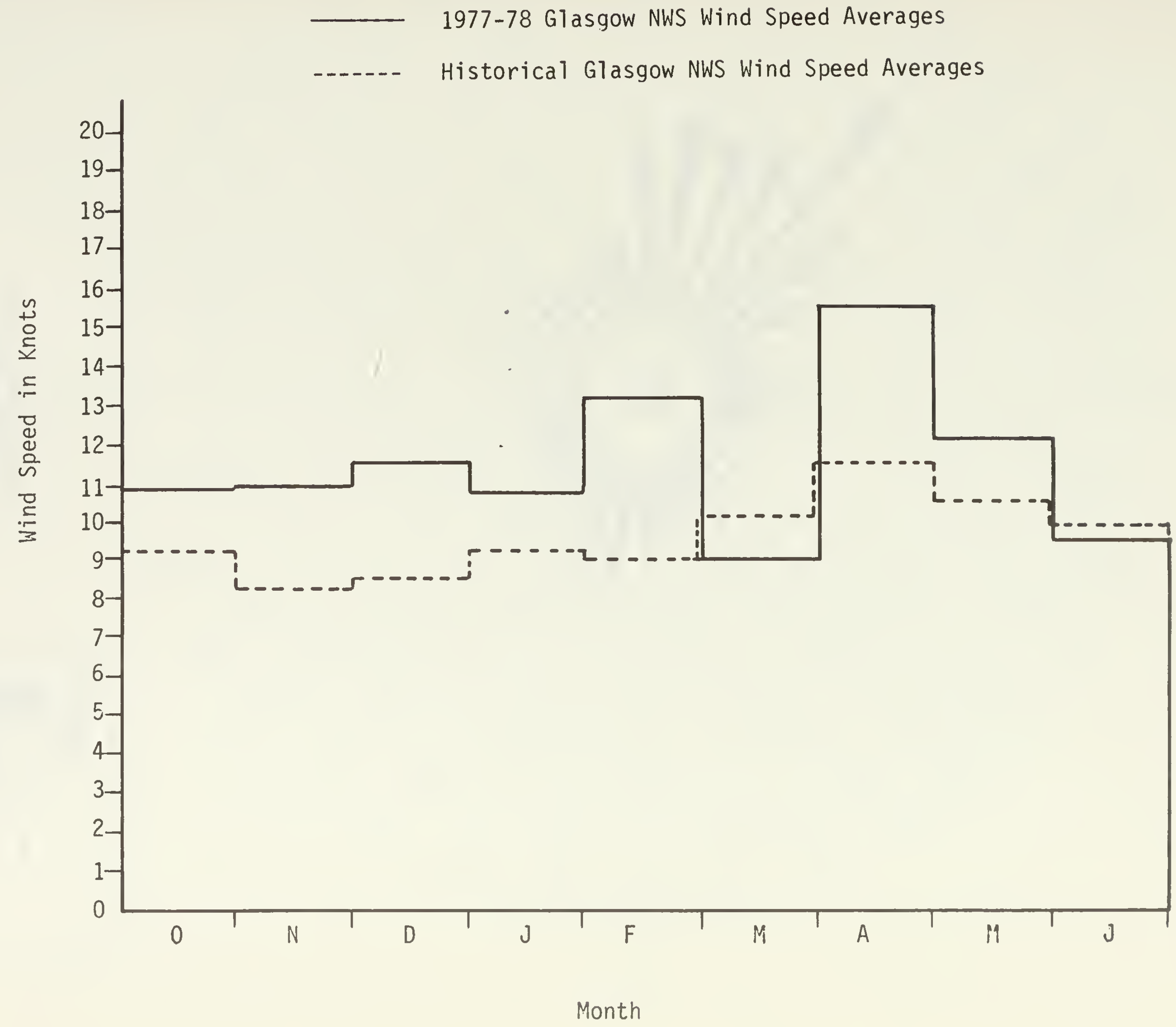
D. Diurnal Wind Pattern Variation

Wind patterns are important in pollution dispersion considerations because they help determine where and with what speed pollutants will be transported. This section examines the seasonal variation of GAFB wind patterns, as well as the variation between daytime and nighttime hours. This is accomplished by using wind roses. A wind rose gives a joint frequency distribution of wind speed and wind direction. Seasons analyzed are fall (October, November, and December), winter (January, February, and March), spring (April, May, and June), and summer (July and August); these seasons are analyzed for daytime (0800 to 1700 MST), nighttime (2000 to 0500 MST), and circadian (all hours) time periods.

1. Fall Wind Patterns

Figures 9A, 9B, and 9C show daytime, nighttime, and circadian fall wind roses. Each of the 36 azimuths represents a wind direction. The concentric circles, in increments of two percent, are a scale of the percentage of time the wind was from different directions. The percentage for each direction is indicated by the bar extending outward from the center along the particular azimuth. The varying widths of the bar indicate different wind speed intervals (defined in the legend) within each wind direction; each section of the bar gives the percentage of the time the wind was both from that particular direction and within that indicated speed range.

Figure 8.-- Comparison of Glasgow NWS 1977-78 Wind Speed Averages with Historical Averages



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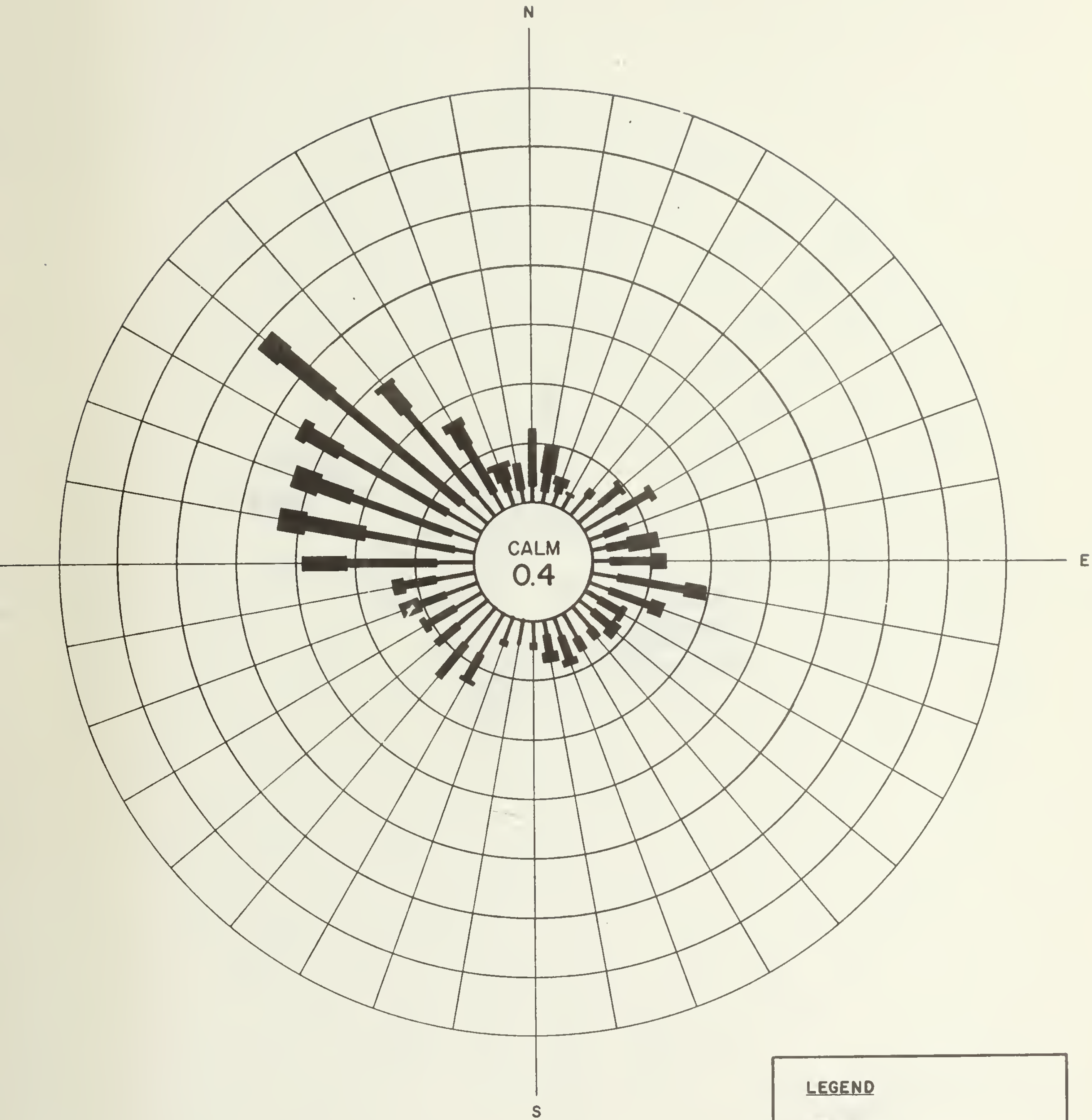

FALL DAYTIME WIND ROSE
10 METER LEVEL
FIG. 9A

LEGEND

12.0 M/S or greater
8.0—11.9 M/S
4.0—7.9 M/S
0.5—3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.

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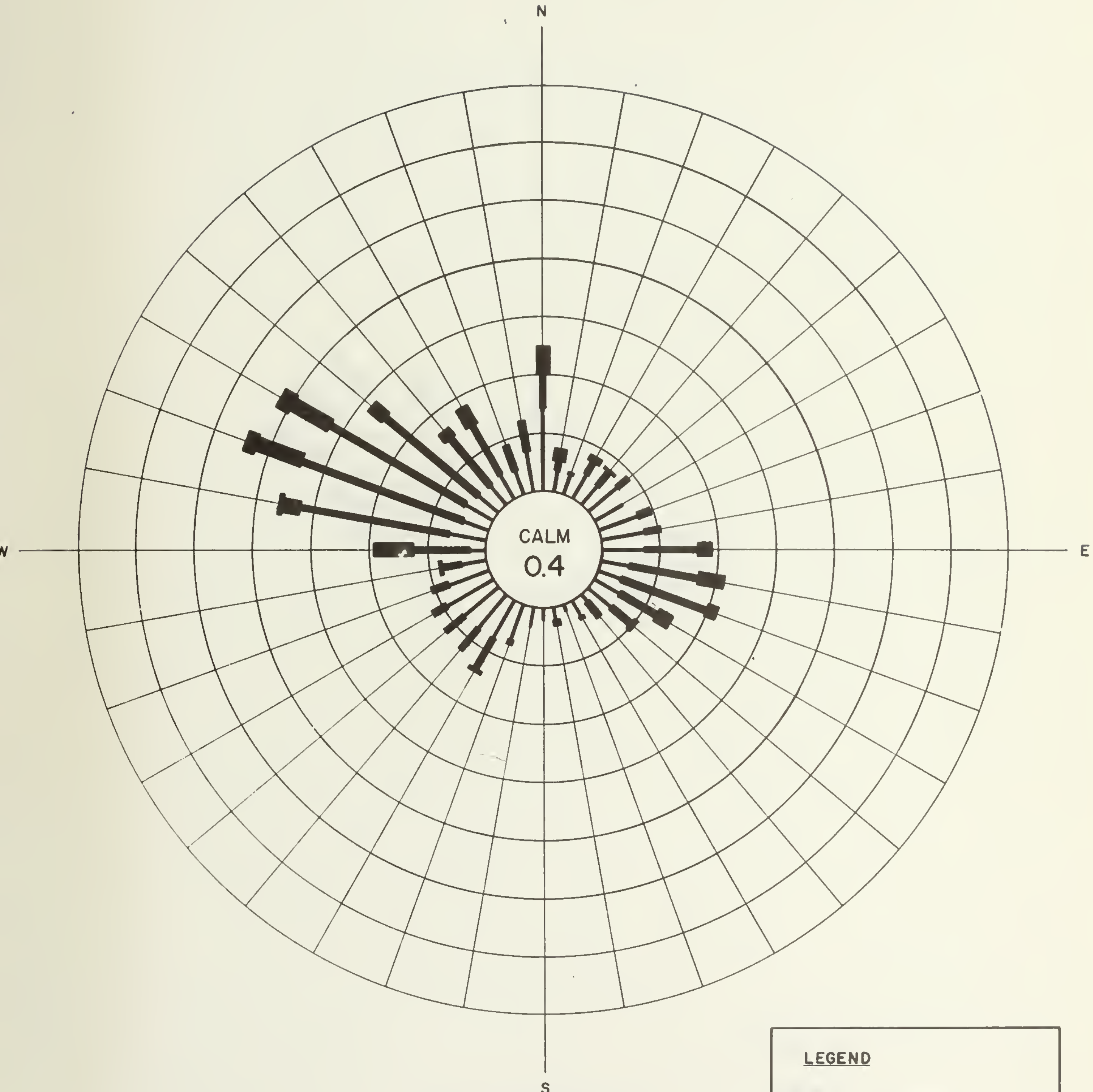
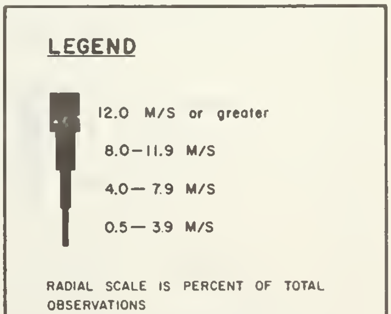
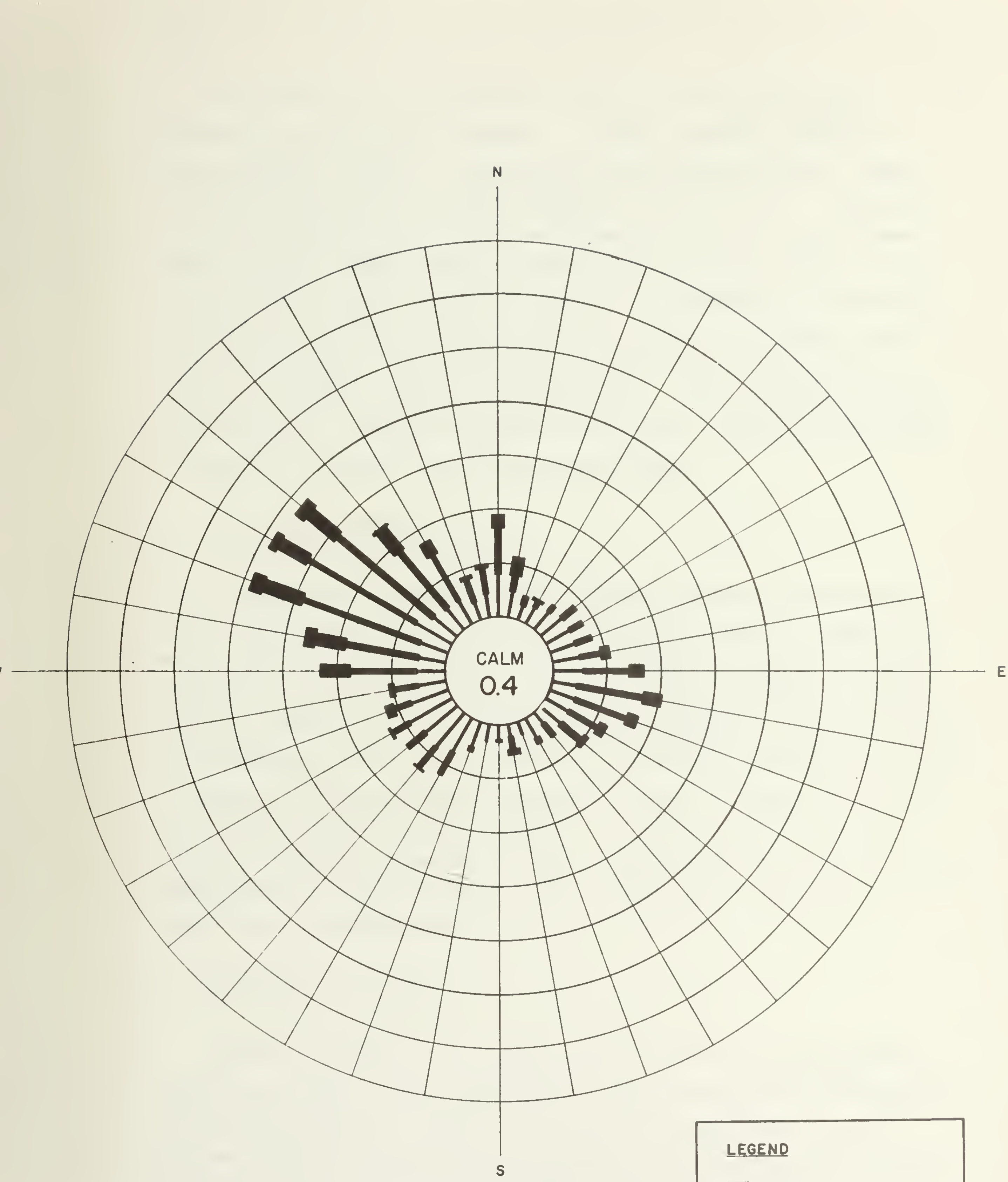
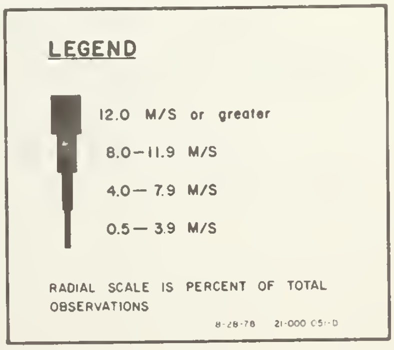


FALL NIGHTTIME WIND ROSE
10 METER LEVEL
FIG. 9B





FALL CIRCADIAN WIND ROSE
10 METER LEVEL
FIG. 9C



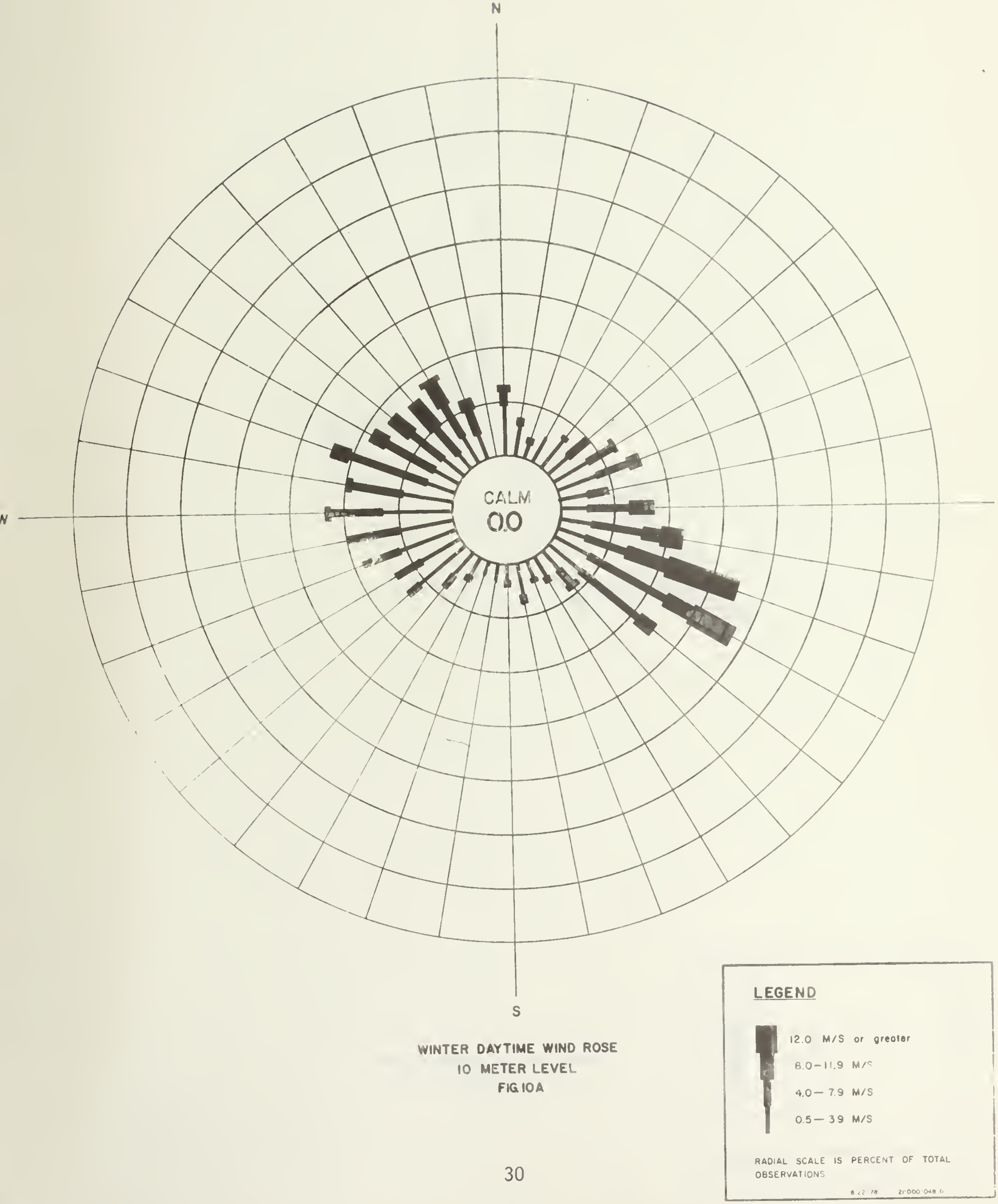
During the fall, northwesterly winds are the most frequently observed, as well as the strongest. A slight secondary maximum in wind speed and frequency is observed for southeasterly winds. Speeds for these directions are usually between 4.0 and 11.9 ms^{-1}. Southerly and northeasterly winds are the least common and usually have speeds below 4.0 ms^{-1}. Winds from other directions are usually below 8.0 ms^{-1} and are below 4.0 ms^{-1} about half the time. Nighttime wind directions are similar to daytime directions with one exception. Winds at 360° are much more common at night than during daytime hours, although this is not true for other northerly wind directions. This indicates a possible drainage effect caused by terrain to the north. Nighttime wind speeds are generally somewhat lower than daytime speeds.

2. Winter Wind Patterns

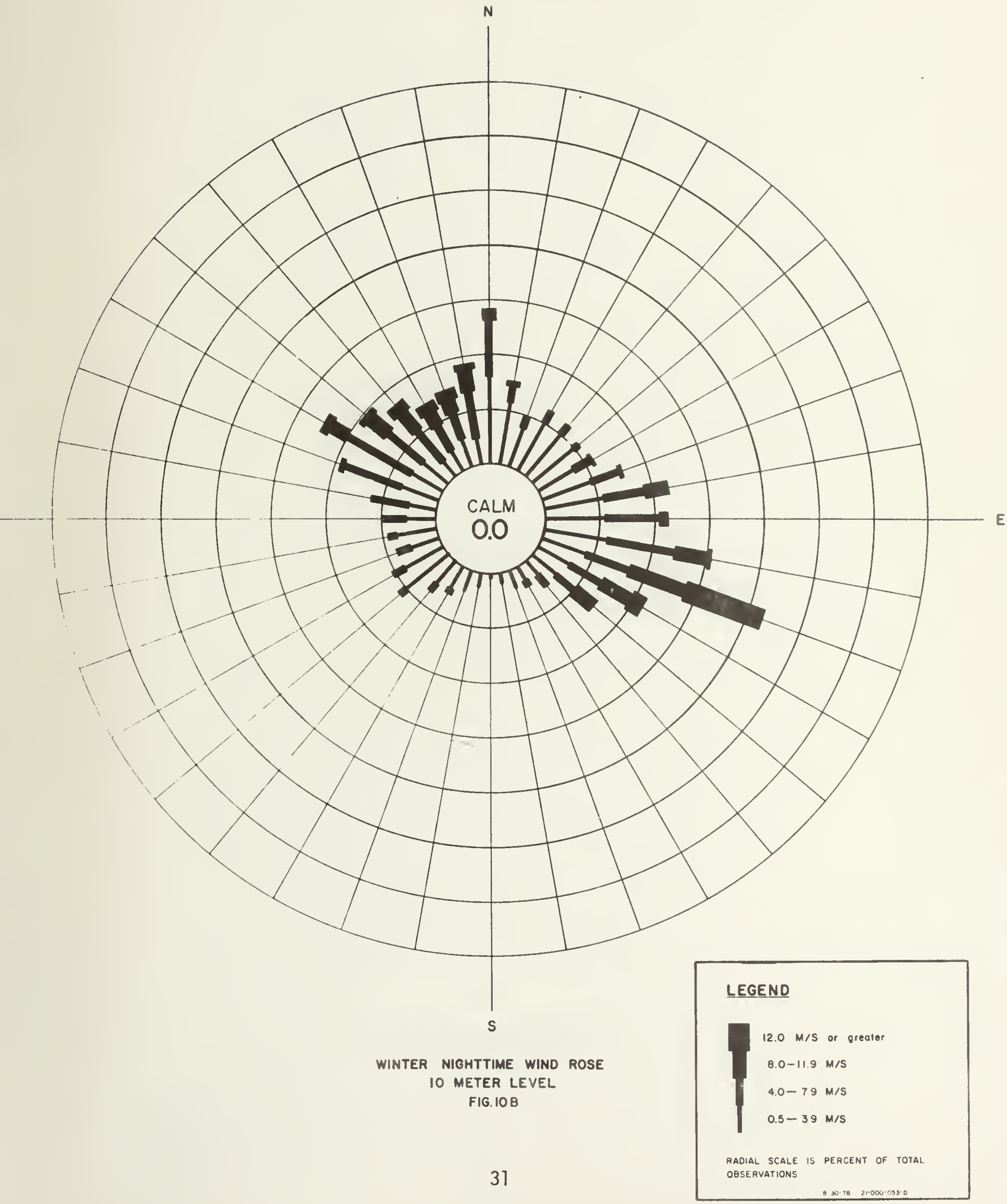
Figures 10A, 10B, and 10C show daytime, nighttime, and circadian winter wind roses. Southeasterly winds are most common in winter, as well as the strongest; secondary maxima in both speed and frequency are observed for northwesterly winds. Southerly and northeasterly winds are the least common; speeds are generally below 4.0 ms^{-1}. The high incidence of southeasterly winds can be explained in part by a storm which occurred in February, bringing strong southeasterly winds to Glasgow for a period of six days along with heavy snowfall. As in the fall, the 360° wind direction is quite pronounced at night but not during the daytime, again indicating a possible drainage effect. A decrease in wind speed is noted during nighttime hours.

3. Spring Wind Patterns

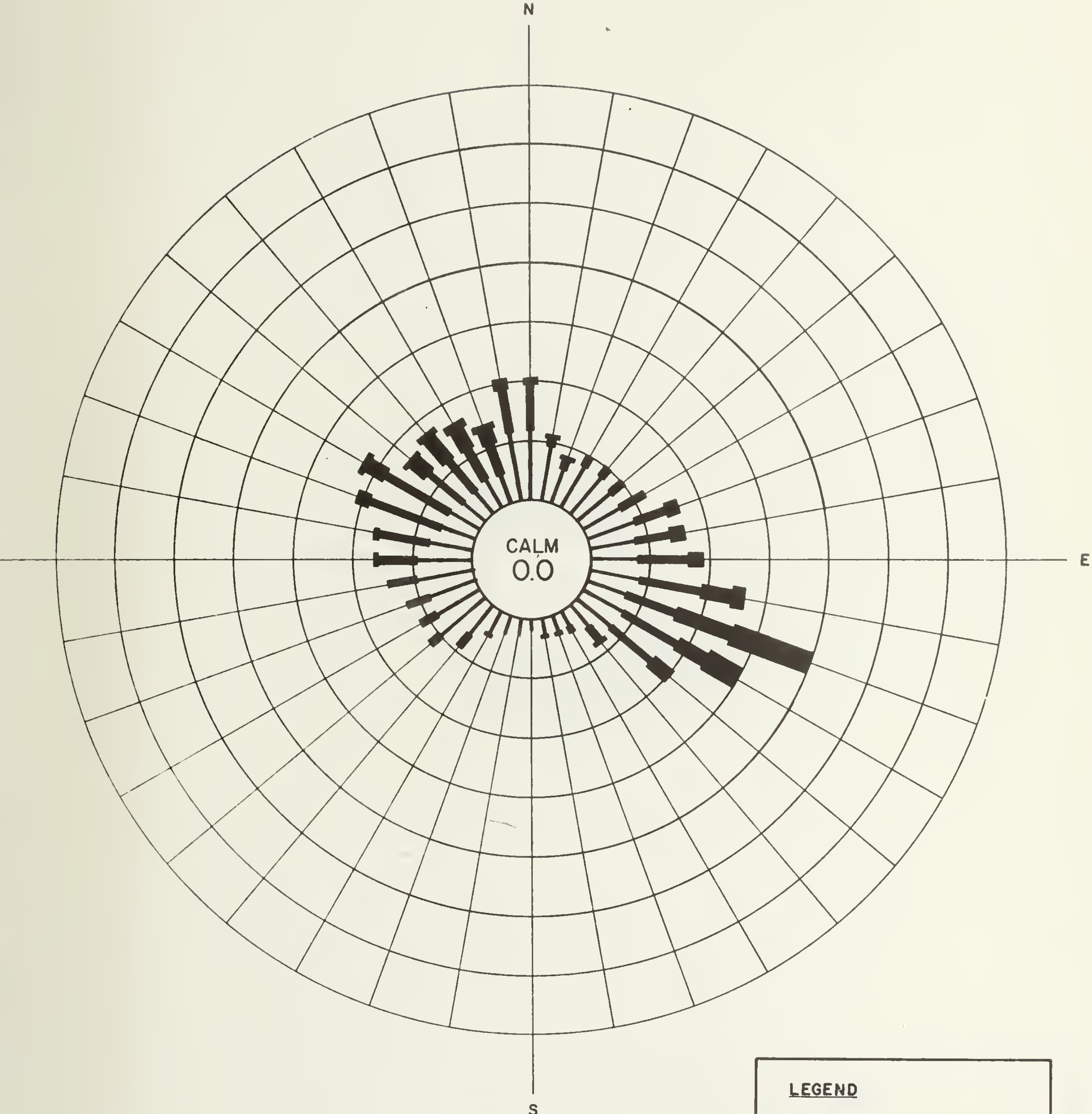
Figures 11A, 11B, and 11C show daytime, nighttime, and circadian spring wind roses. Spring wind patterns differ considerably from fall and winter patterns; a substantial increase in wind speed is noted. Northwesterly and southeasterly winds are the most common but are less pronounced than during fall and winter; these winds are also the strongest. Southwesterly and northeasterly winds are least common and



WINTER DAYTIME WIND ROSE
10 METER LEVEL
FIG.10A



WINTER NIGHTTIME WIND ROSE
10 METER LEVEL
FIG. 10B



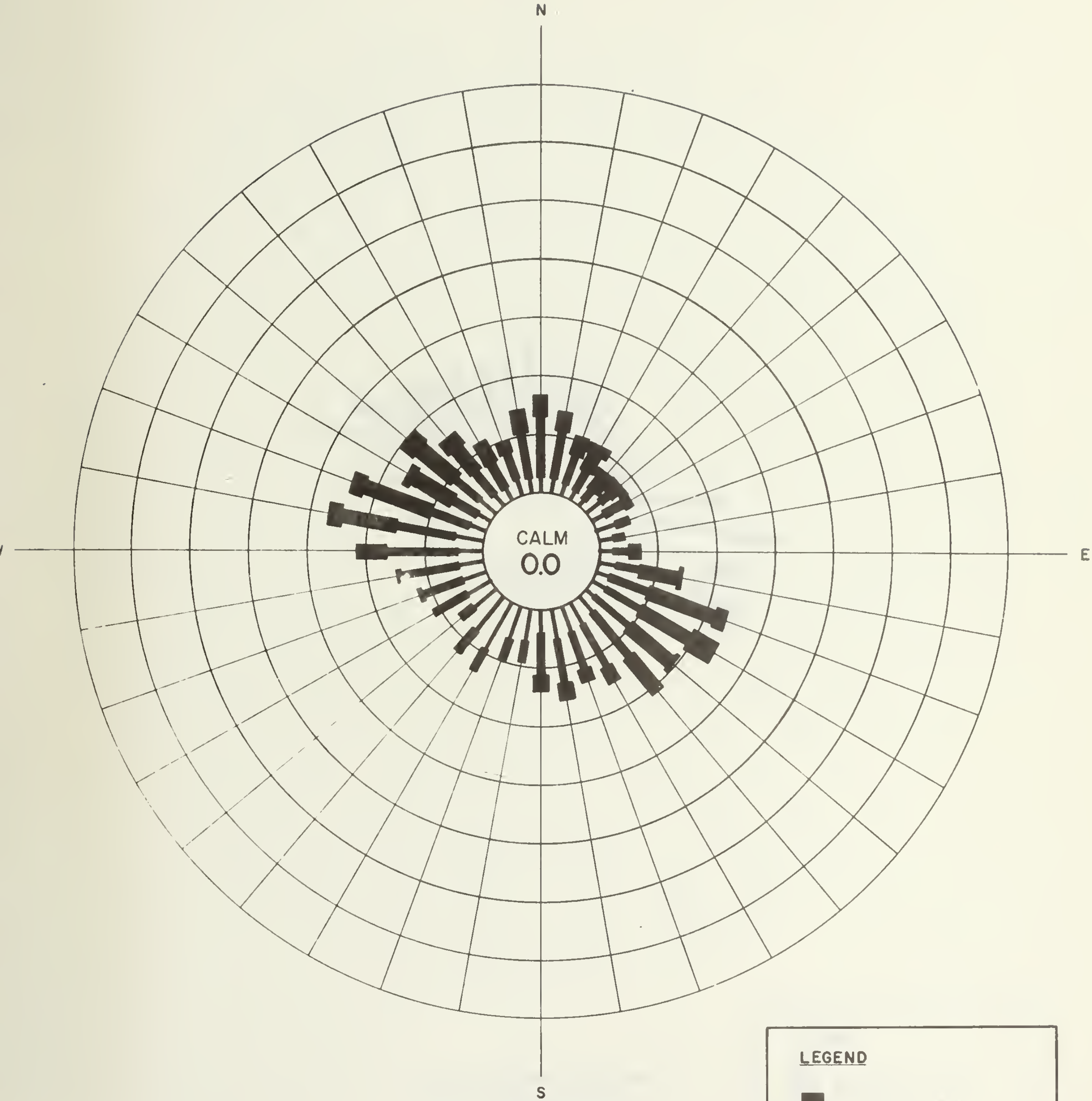
WINTER CIRCADIAN WIND ROSE
10 METER LEVEL
FIG.10C

LEGEND

12.0 M/S or greater
8.0–11.9 M/S
4.0–7.9 M/S
0.5–3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS

8-21-78 21-000-047-D

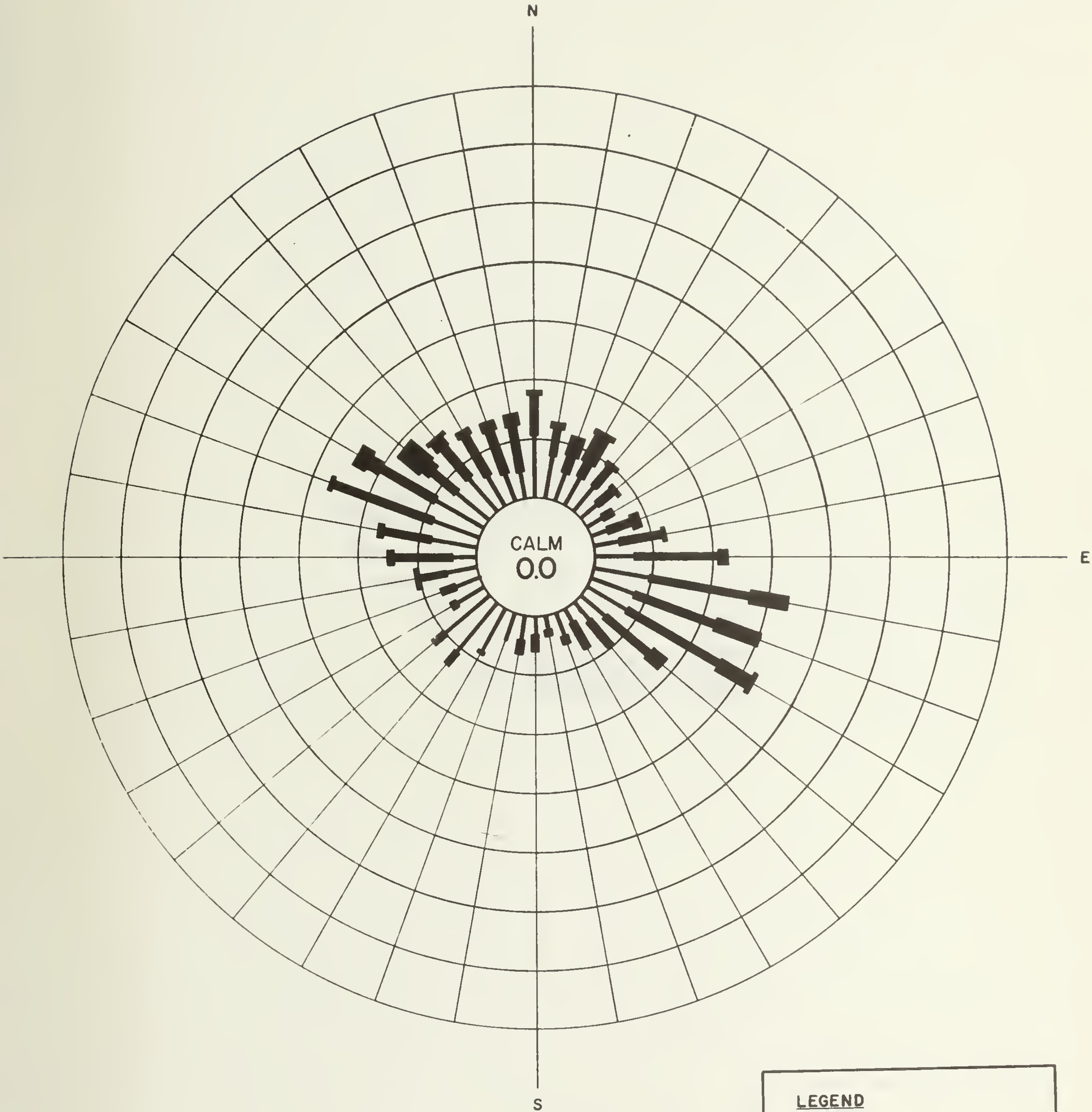


SPRING DAYTIME WIND ROSE
10 METER LEVEL
FIG. 11A

LEGEND

12.0 M/S or greater
8.0—11.9 M/S
4.0— 7.9 M/S
0.5— 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS



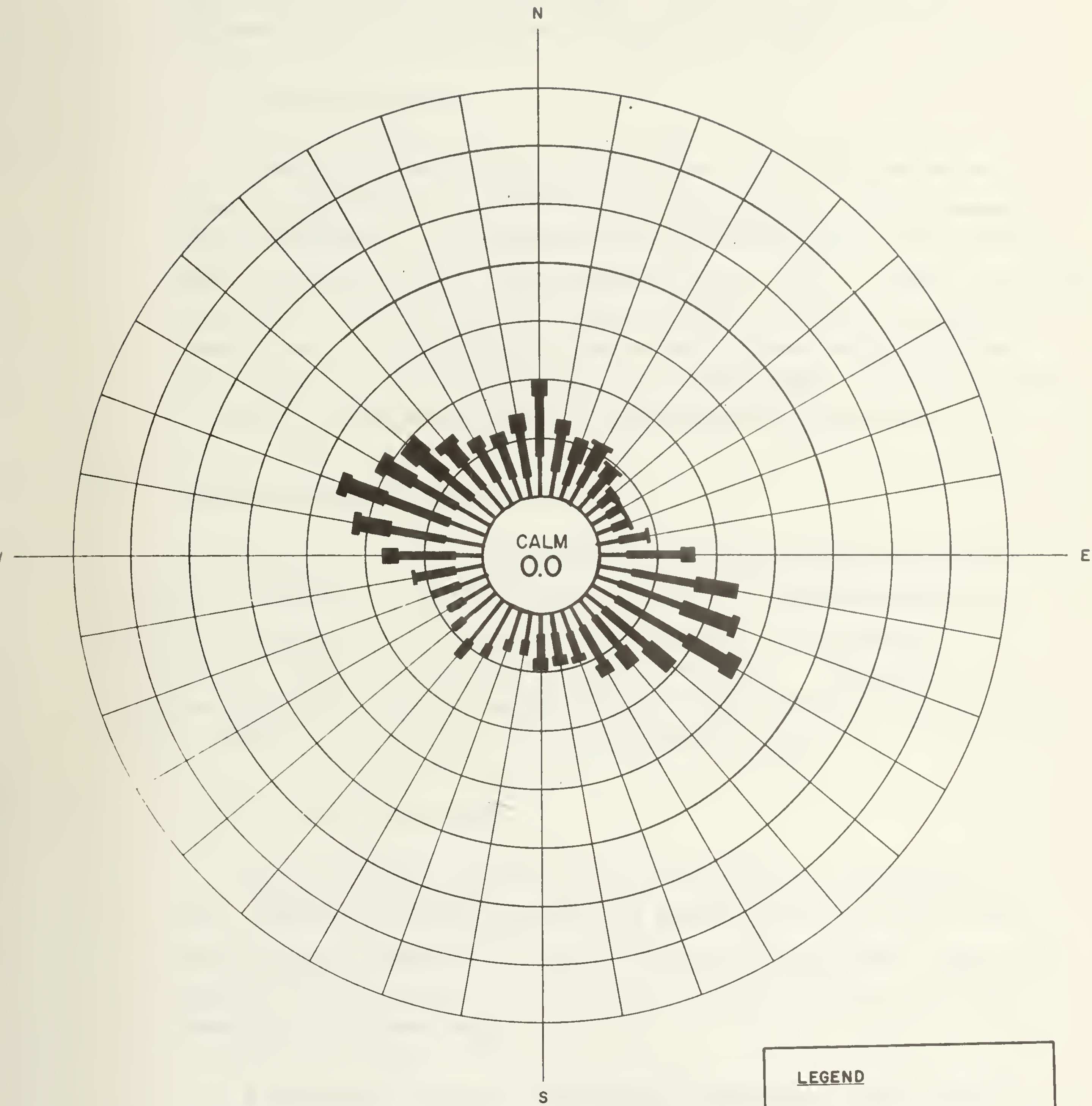
SPRING NIGHTTIME WIND ROSE
10 METER LEVEL
FIG. 11B

LEGEND

12.0 M/S or greater
8.0–11.9 M/S
4.0– 7.9 M/S
0.5– 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS

9 /8 21-000-054-0



SPRING CIRCADIAN WIND ROSE
10 METER LEVEL
FIG.11C

LEGEND

12.0 M/S or greater
8.0—11.9 M/S
4.0— 7.9 M/S
0.5— 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS

8 29 78 21 000 052 0

are usually light. There is no indication of a nocturnal 360° drainage wind, unlike the fall and winter cases. The nighttime wind speed decrease is more pronounced than during fall and winter.

4. Summer Wind Patterns

Summer wind speeds are considerably lower than in the spring as shown in Figures 11D, 11E, and 11F; wind directions are similar however. West-northwesterly and southeasterly winds predominate; as in the spring, these direction maxima are less pronounced than in fall or winter. Southerly and easterly winds are the least common; these directions also show the lowest speeds. The possible drainage effect observed during nighttime hours in fall and winter also is observed during summer. As in the spring, a substantial wind speed decrease is noted during nighttime hours.

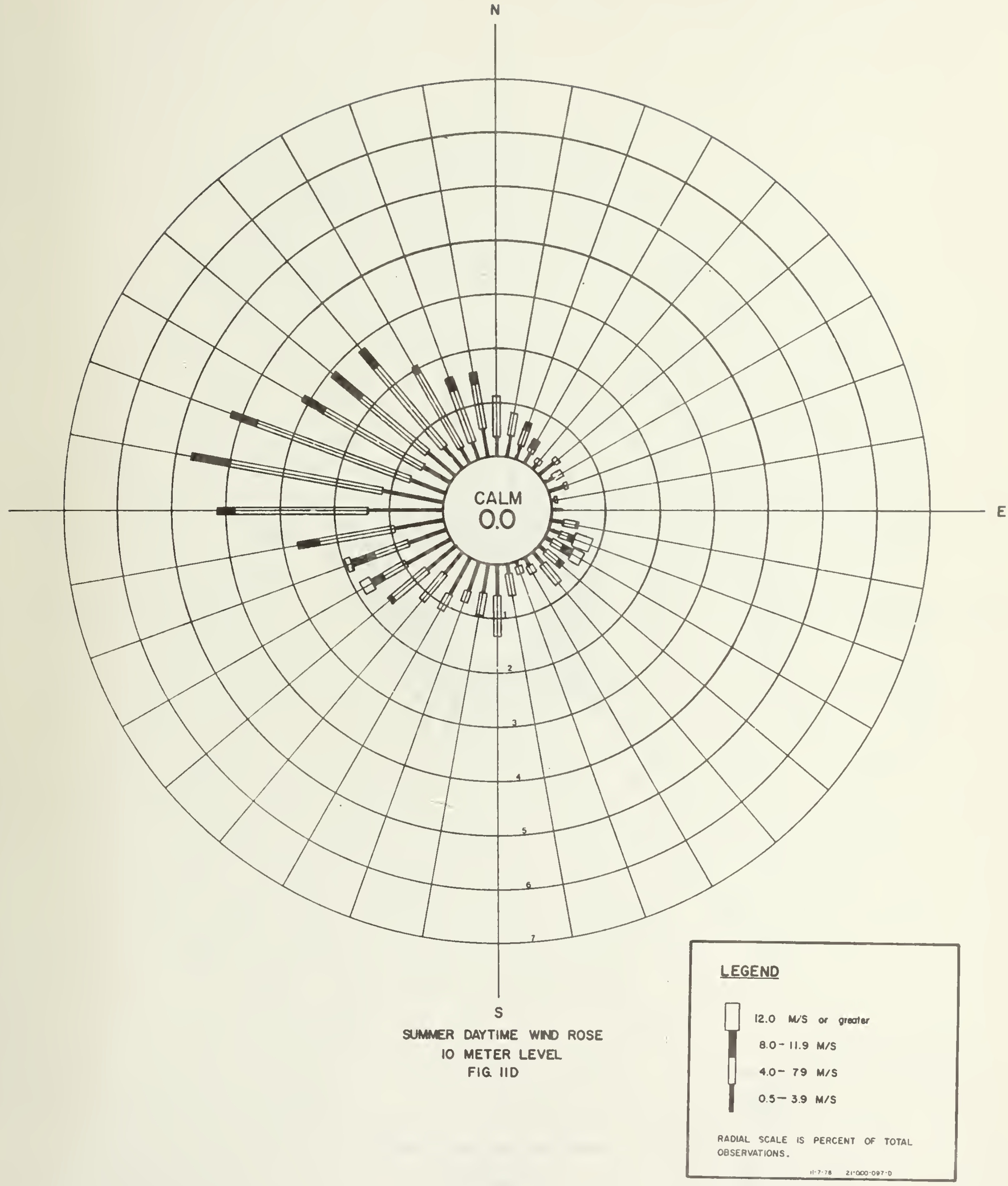
E. Atmospheric Stability Characteristics

One important factor influencing the pollution dispersion potential of an area is atmospheric stability, defined by Pasquill stability categories which were described in Section IID. It is necessary to describe the variation of stability with season and with time of day. Time periods analyzed are 0100 to 0600 MST (early morning), 0700 to 1200 MST (late morning), 1300 to 1800 MST (afternoon),and 1900 to 2400 MST (evening).

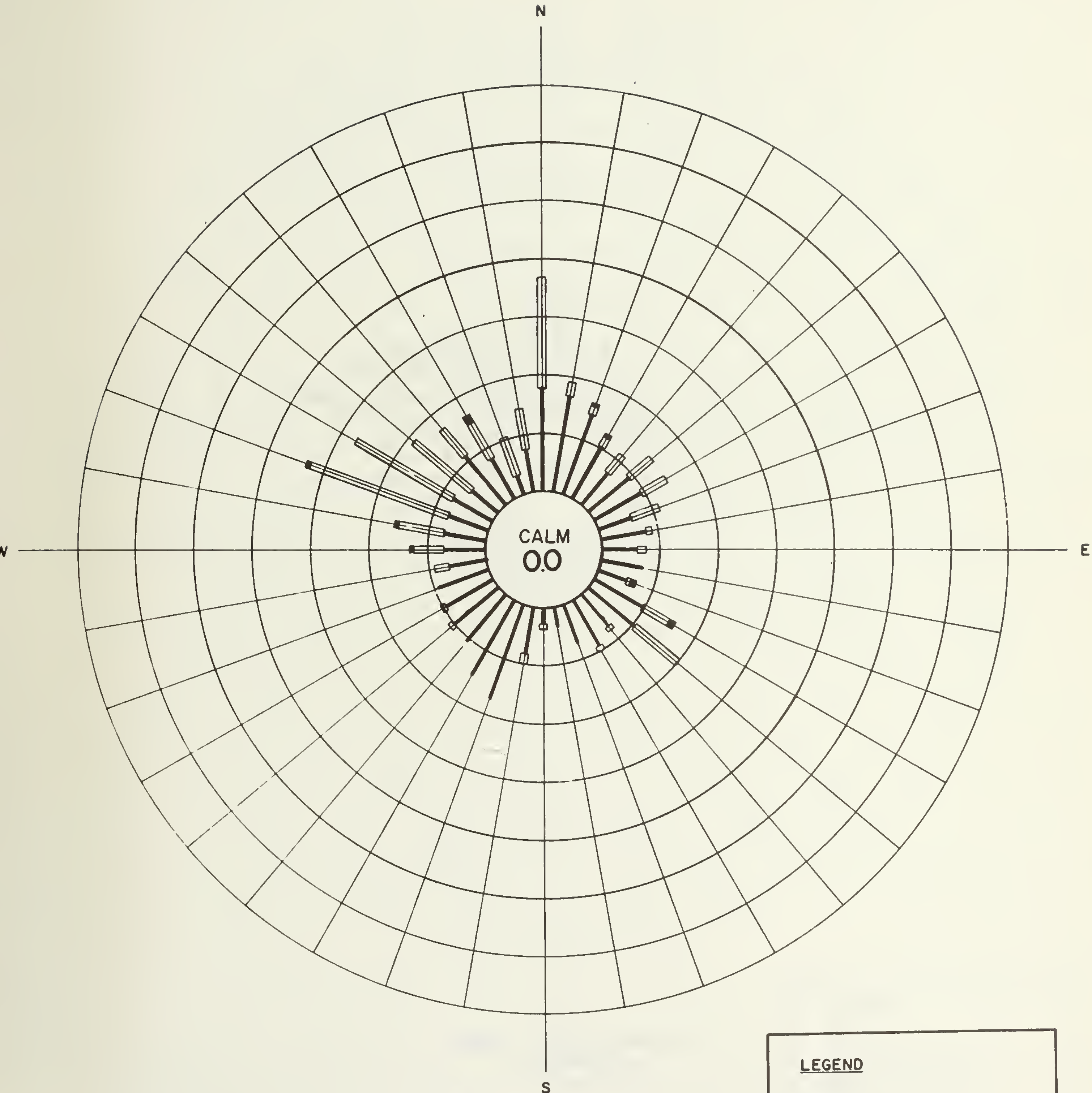
1. Fall Stability Patterns

Figure 12A shows stability category frequency distributions for fall. Stable conditions occur about 83 percent of the time during early morning hours; categories E, F, and G occur with nearly equal frequencies. Neutral conditions occur 17 percent of the time; no unstable cases were observed during these hours.

A substantial change is noted during late morning hours; neutral conditions occur about 45 percent of the time. Stable cases occur about



SUMMER DAYTIME WIND ROSE
10 METER LEVEL
FIG. 11D



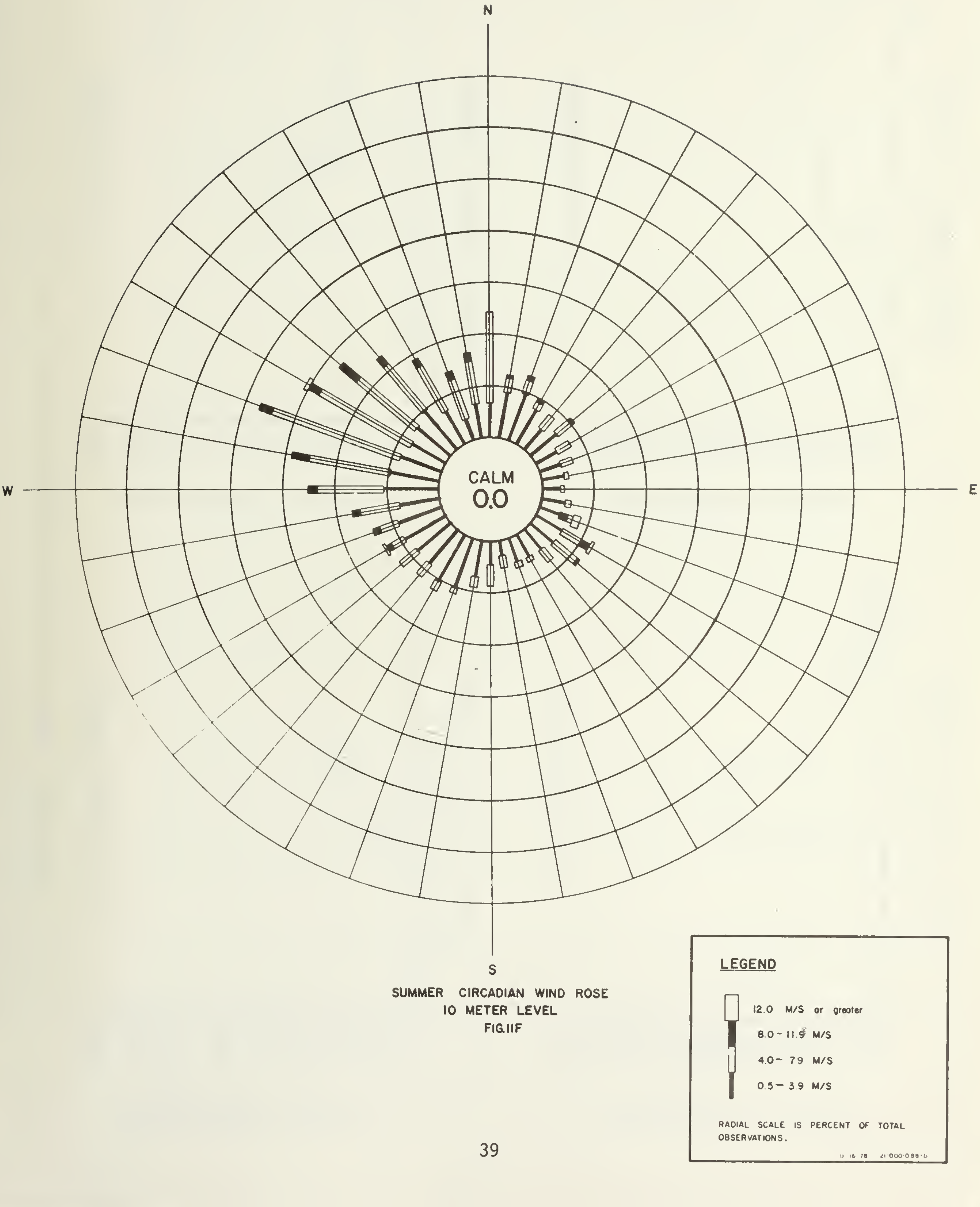
SUMMER NIGHTTIME WIND ROSE
10 METER LEVEL
FIG. 11E

LEGEND

12.0 M/S or greater
8.0 – 11.9 M/S
4.0 – 7.9 M/S
0.5 – 3.9 M/S

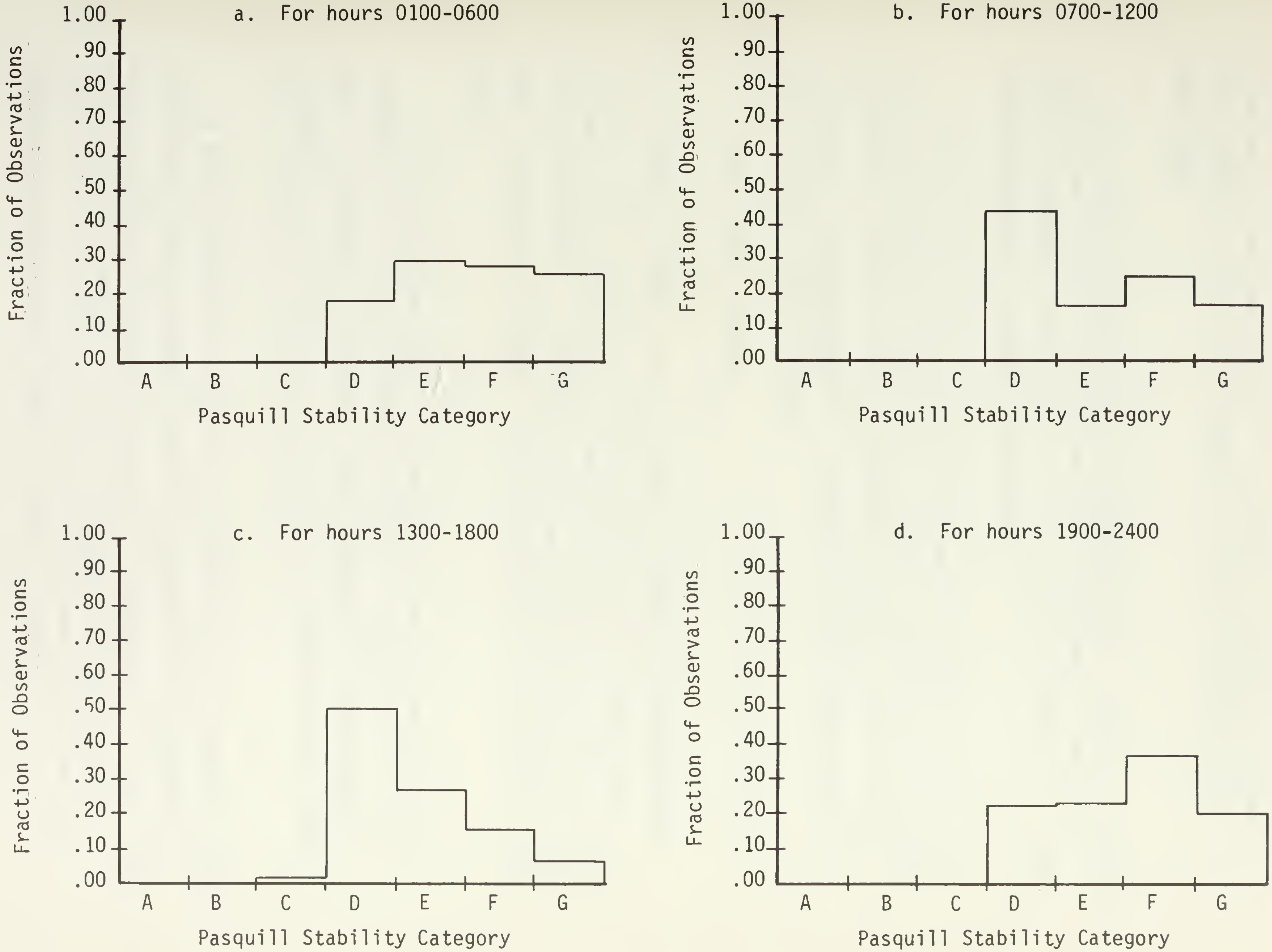
RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.

10-17-78 21-000-087-D



SUMMER CIRCADIAN WIND ROSE
10 METER LEVEL
FIG.11F

Figure 12A.--Stability Category Frequency Distributions For Fall



9-7-78 21-000-057-A

55 percent of the time; category F is observed slightly more often than categories E and G. No unstable cases were observed during these hours.

This trend continues during the afternoon hours. Neutral conditions are observed 51 percent of the time, and a few category C (unstable) cases are observed. Categories E, F, and G occur 27 percent, 17 percent, and seven percent of the time, respectively.

During evening hours, conditions become more stable; neutral cases occur only 22 percent of the time. Category F conditions are observed 38 percent of the time, while categories E and G each occur in about 20 percent of the observations. This indicates conditions similar to those observed in early morning.

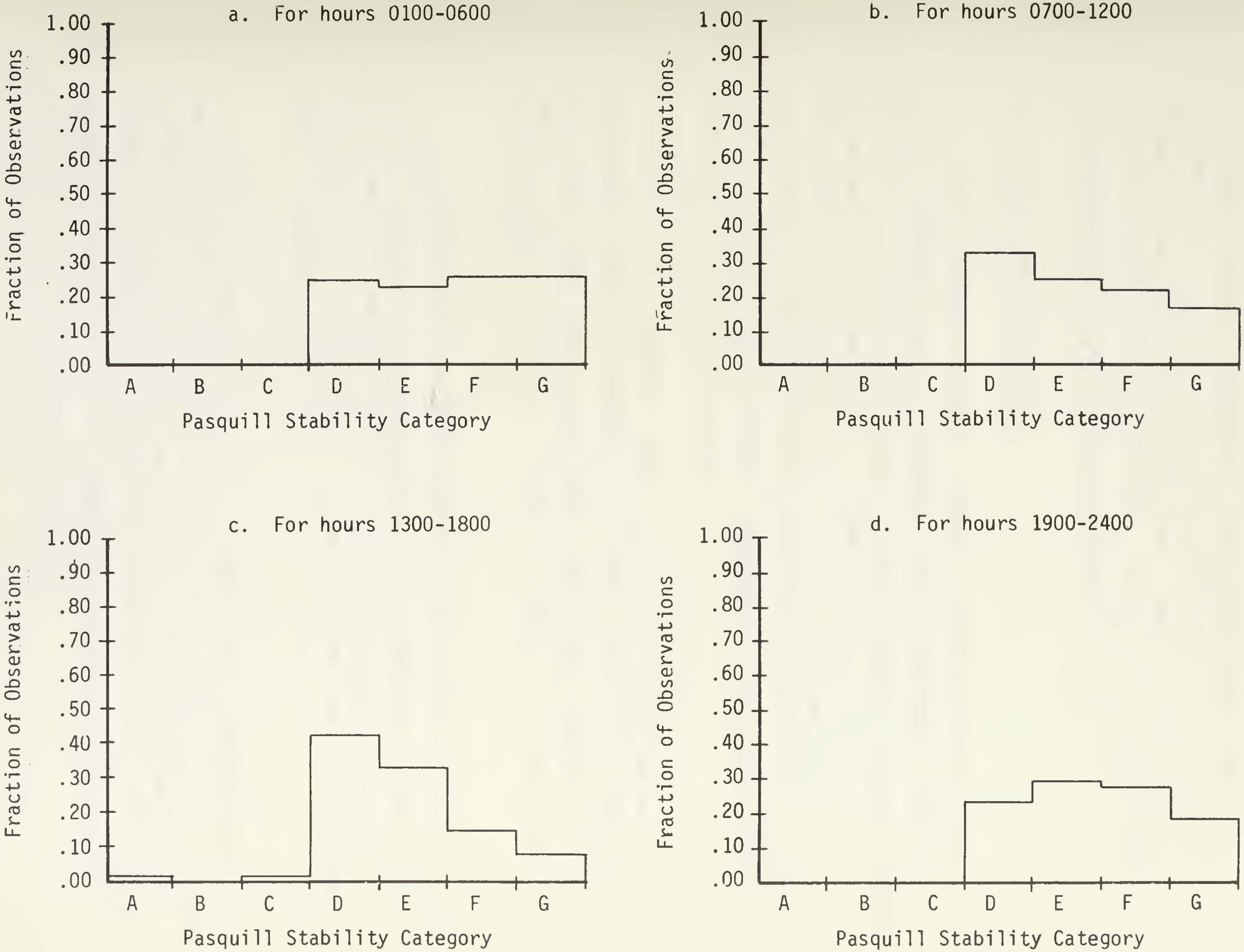
2. Winter Stability Patterns

Figure 12B shows stability category frequency distributions for winter. Stable conditions predominate during early morning hours in winter, with categories E, F, and G each occurring in about 25 percent of the observations. No unstable cases were observed during these hours. These conditions are similar to those observed in fall during this time period.

Stable conditions occur in 65 percent of the late morning observations; no unstable conditions are observed. Categories E, F, and G occur in 20 percent, 22 percent, and 17 percent of the late morning observations, respectively. This indicates slightly more stable late morning conditions in winter than in fall.

A further decrease in stability is observed during afternoon hours with neutral cases occurring in about 42 percent of the observations; unstable cases are observed occassionally. Categories E, F, and G occur in 32 percent, 14 percent, and eight percent of the observations, respectively. Again, this indicates slightly more stable conditions than are observed in fall during the same time period.

Figure 12B.--Stability Category Frequency Distributions For Winter



9-7-78 21-000-056-A

Stable conditions predominate during evening hours, with categories E, F, and G occurring in 29 percent, 27 percent, and 18 percent of the observations, respectively. Neutral conditions occur in only 23 percent of the observations. Slightly less stable conditions are observed than during this same time period in fall.

3. Spring Stability Patterns

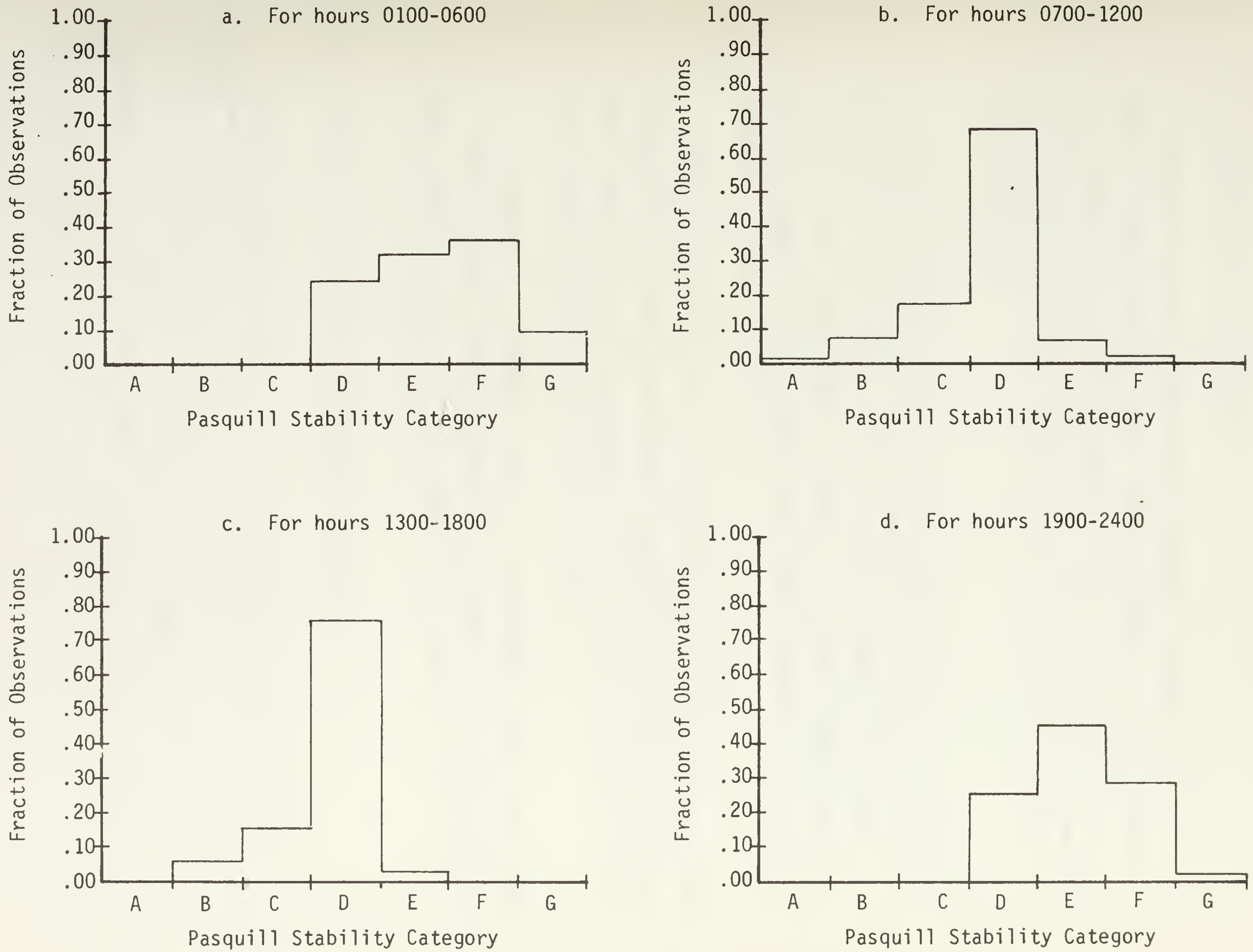
Figure 12C shows stability category frequency distributions for spring. Springtime stability patterns differ considerably from those observed in fall and winter. Neutral conditions occur in about 25 percent of the observations during early morning hours, as in fall and winter. Note, however, that category G (very stable) conditions occur in only nine percent of the early morning observations, compared with 25 percent in fall and winter. This indicates substantially less stable conditions during early morning in the spring.

Late morning conditions differ greatly from those observed in fall and winter. Neutral conditions occur in 68 percent of the observations, and unstable conditions are more common than stable conditions. This indicates much more unstable late morning conditions in spring than in fall or winter.

This trend continues during afternoon hours; stable conditions occur in only 39 percent of the observations, while unstable conditions occur in 21 percent of the observations. Neutral conditions are observed 76 percent of the time. Again, this indicates more unstable conditions than are observed in fall and winter.

A shift to more stable conditions occurs during evening hours; neutral conditions occur in only 26 percent of the observations. Category E conditions, the most common, occur in 46 percent of the observations. Category G conditions are observed only two percent of the time, compared to about 20 percent in fall and winter; this indicates much less stable conditions in spring during this time period.

Figure 12C.--Stability Category Frequency Distributions For Spring



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4. Summer Stability Patterns

Figure 12D shows summer stability category frequency distributions. In early morning, neutral conditions occur in only one percent of the observations, while category E, F, and G conditions occur in 29 percent, 38 percent, and 32 percent of the observations, respectively. This indicates more stable conditions than were observed in spring during these hours.

During late morning hours, neutral conditions occur in 45 percent of the observations, while unstable conditions are observed about 38 percent of the time. During these hours, both stable and unstable conditions are more common than in spring, while neutral conditions are much less common. This suggests that late morning stability is more variable in summer than in spring.

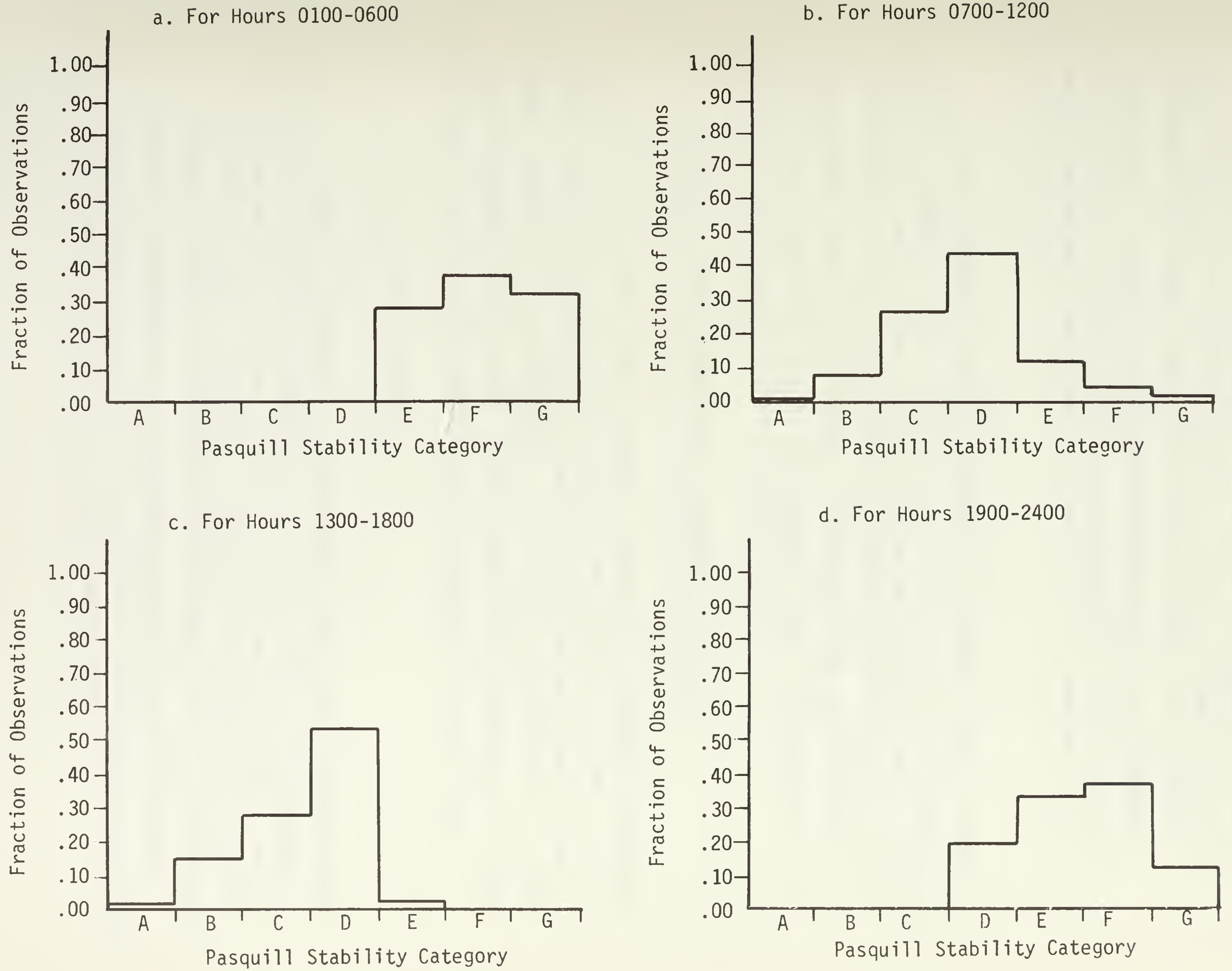
Neutral conditions occur in about 53 percent of the afternoon observations, while unstable conditions are observed 45 percent of the time. Stable conditions almost never occur. This indicates slightly more unstable conditions than are observed in spring.

Conditions are generally stable in the evening; neutral cases occur in only 20 percent of the observations. Category F and G conditions are more common than in spring. This suggests that evening conditions are more stable in summer than in spring.

F. Relation of σH and σV to Atmospheric Stability

Another important factor in pollution dispersion considerations is atmospheric turbulence, defined in terms of σH and σV (the ten-minute standard deviations of the horizontal and vertical wind directions, respectively). Turbulence can be thought of as the amount of "breaking up" motion in the atmosphere. Since atmospheric stability and turbulence both influence pollution dispersion, it is desirable to examine the inter-relationship of these two parameters.

Figure 12D.--Stability Category Frequency Distributions for Summer



10-4-78 21-000-069-A

Figures 13A1 and 13A2 depict average values of σH and σV at the ten-meter level for each stability category, as well as standard deviations, indicated by the dotted lines. σH and σV are highest during category C conditions; the lowest values are observed during stable temperature stratifications. σV values tend to be lower than σH, especially during neutral and unstable conditions. High variability is observed in both of these parameters.

Figure 13B shows σH and σV averages at the 100-meter level for each stability category. Note that σH values are lower than at the ten-meter level. However, the overall trend is similar; σH values are highest during category C conditions and lowest during stable conditions; σH also decreases during more unstable conditions. σV values at 100 meters more nearly follow the same trends as σH values than at the ten-meter level. High variability is observed in both parameters at the 100-meter level.

G. Variation of Wind Patterns With Atmospheric Stability

Section IIIE described the seasonal and diurnal variation of atmospheric stability at GAFB. It is also desirable to describe wind patterns observed during different stabilities, as winds help determine where and with what speed pollutants will be transported. This section describes the variation of wind patterns with stability for each season; wind patterns are analyzed for each of the four most common stability categories for each season.

1. Fall Stability Wind Roses

Figures 14A through 14D show November wind roses for the ten-meter level for stability categories D, E, F, and G, which are representative of the variation of winds with stability observed during fall. During stability category D conditions, northerly and northwesterly winds predominate. Southerly winds are the least common, as well as the lightest. Northerly, northwesterly, and southeasterly winds are the strongest; speeds between 4.0 and 11.9 ms^{-1} are the rule. Wind speeds during category D conditions are fairly high, averaging nearly 6 ms^{-1}.

Figure 13A1.--σH Averages for 10-Meter Level

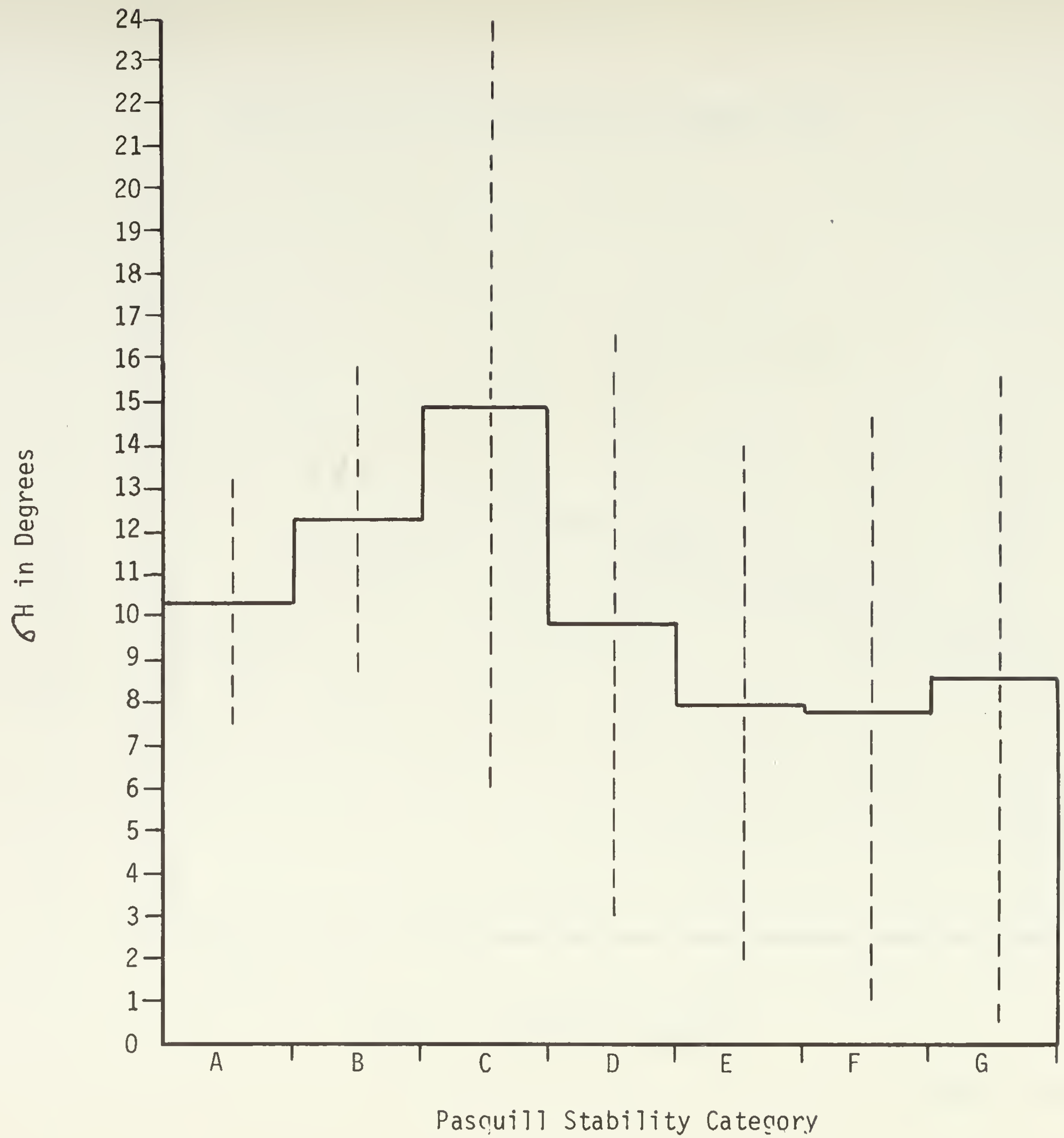


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Figure 13A2.--σv Average for 10-Meter Level

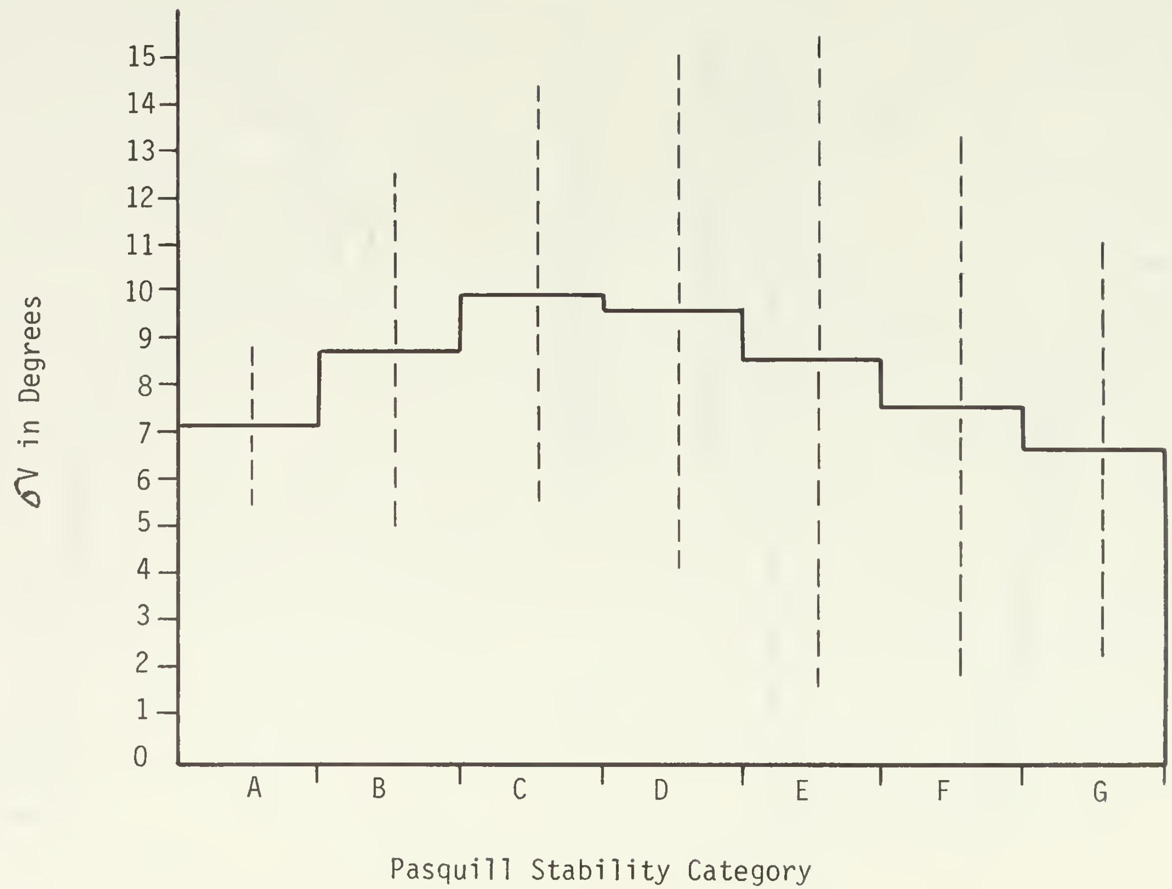

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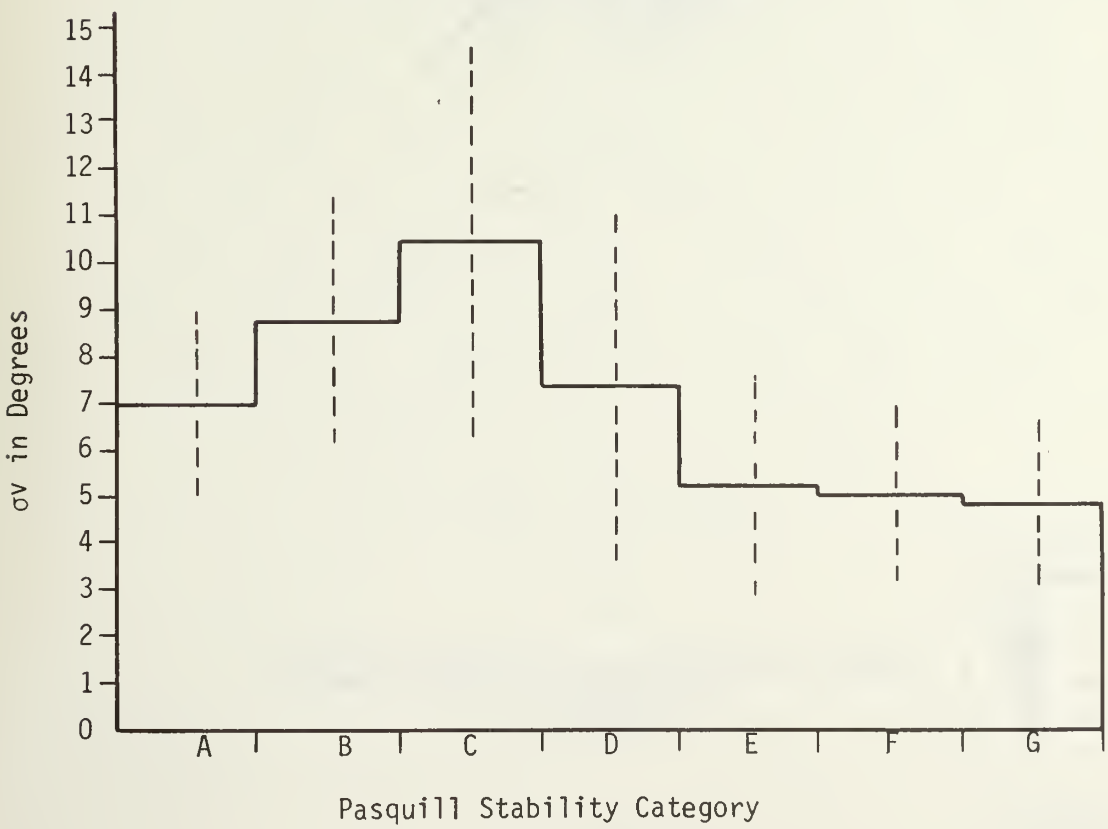
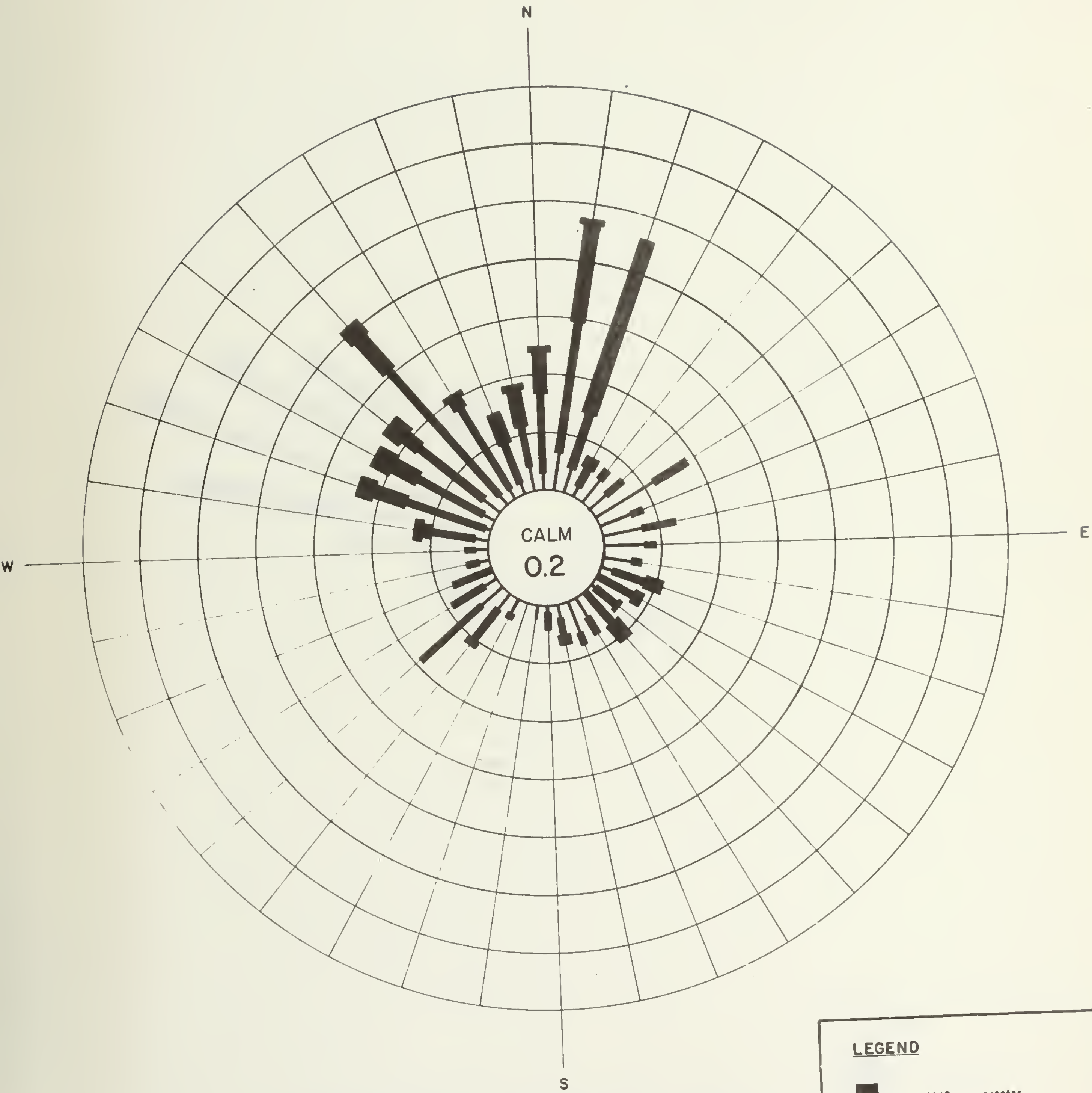
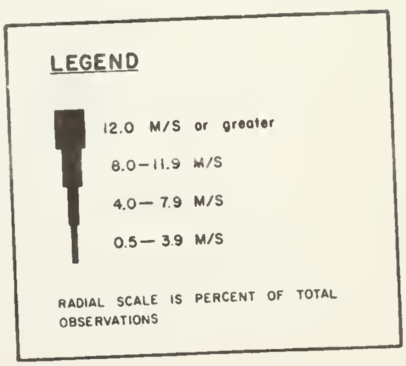
Figure 13B.--σH Averages for 100-Meter Level

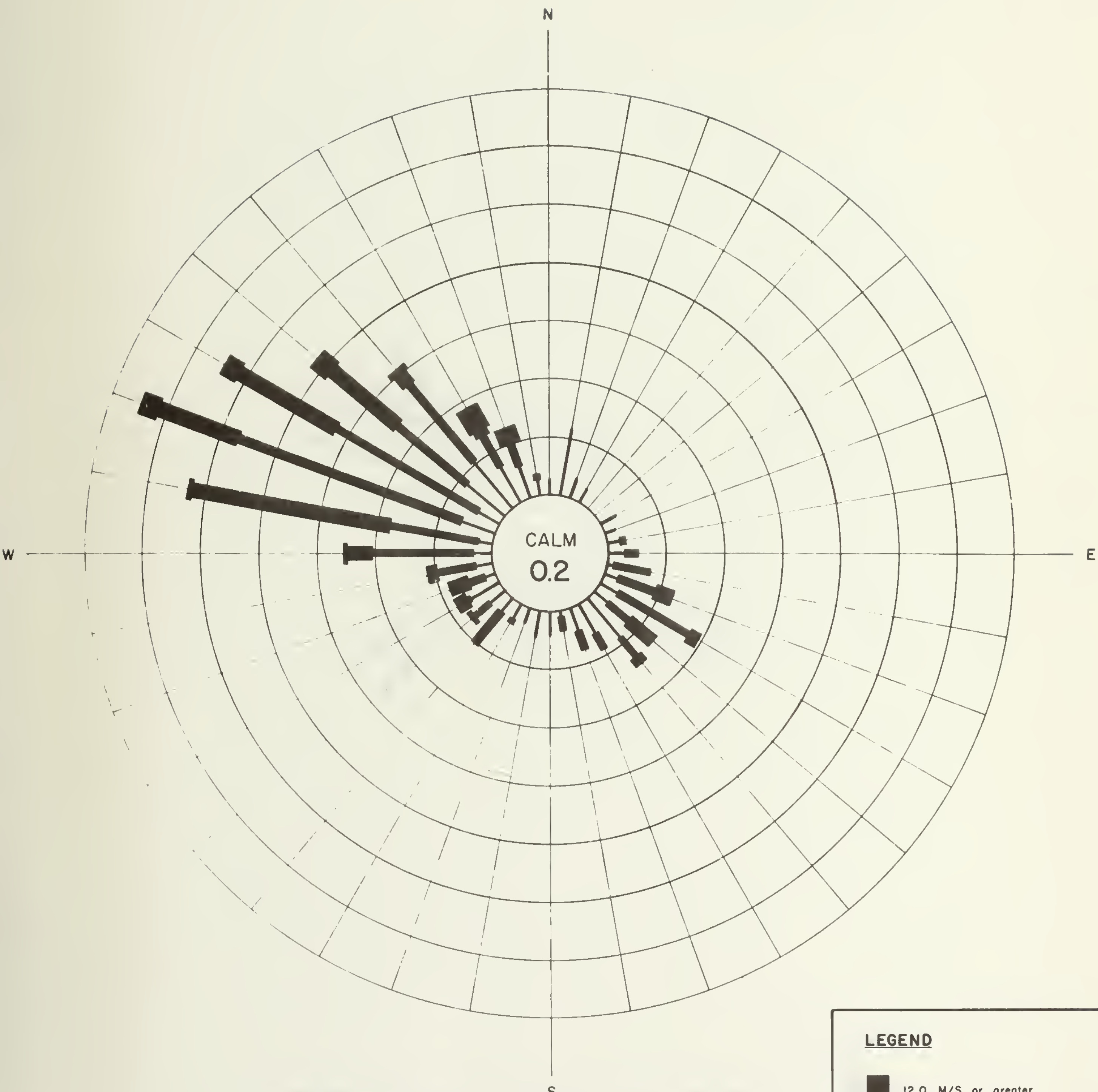
σH Averages for 100-Meter Level



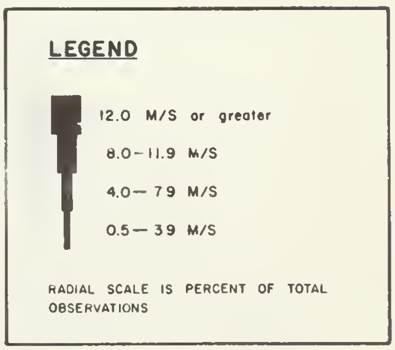


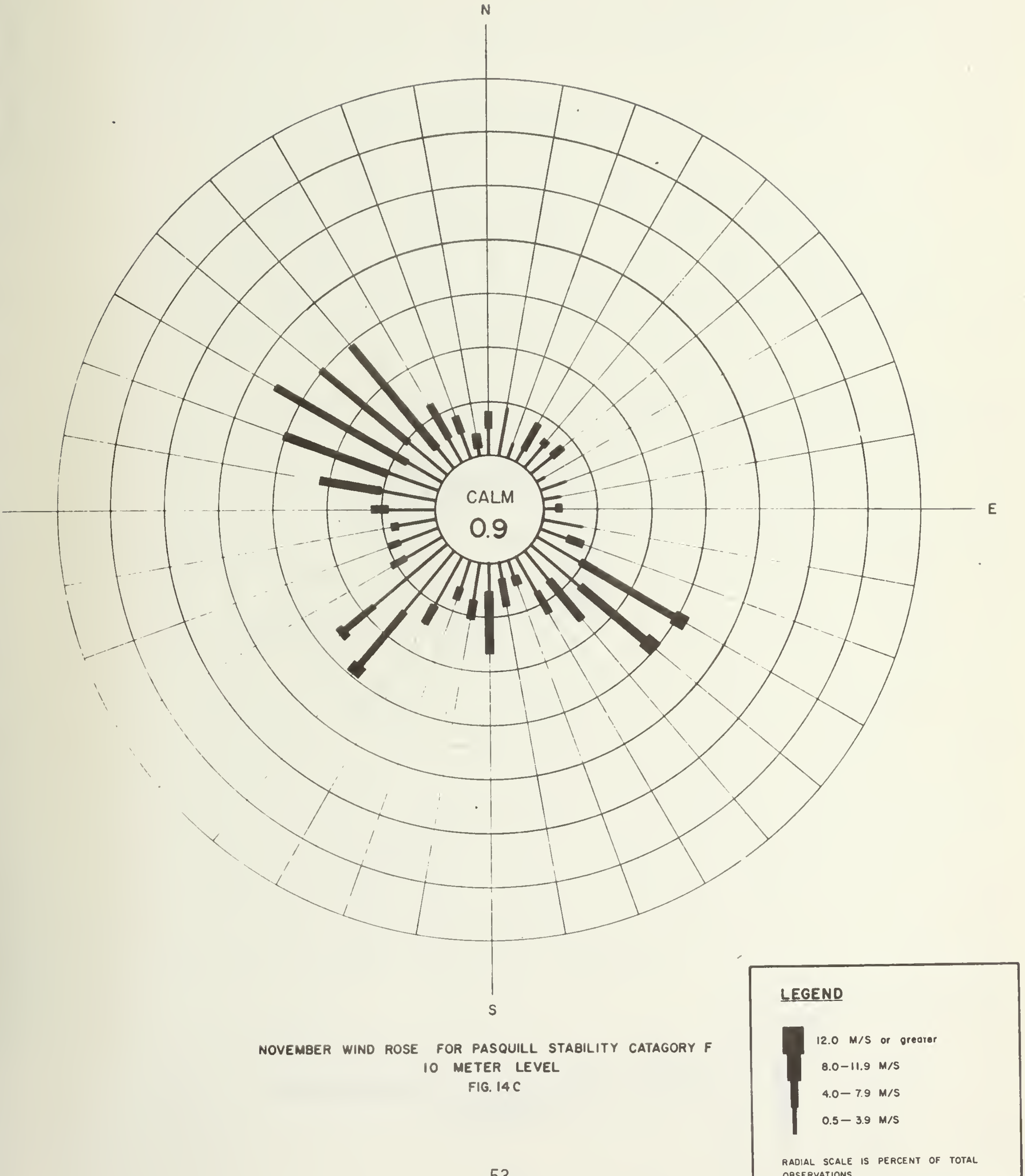
NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY D
10 METER LEVEL
FIG. 14 A



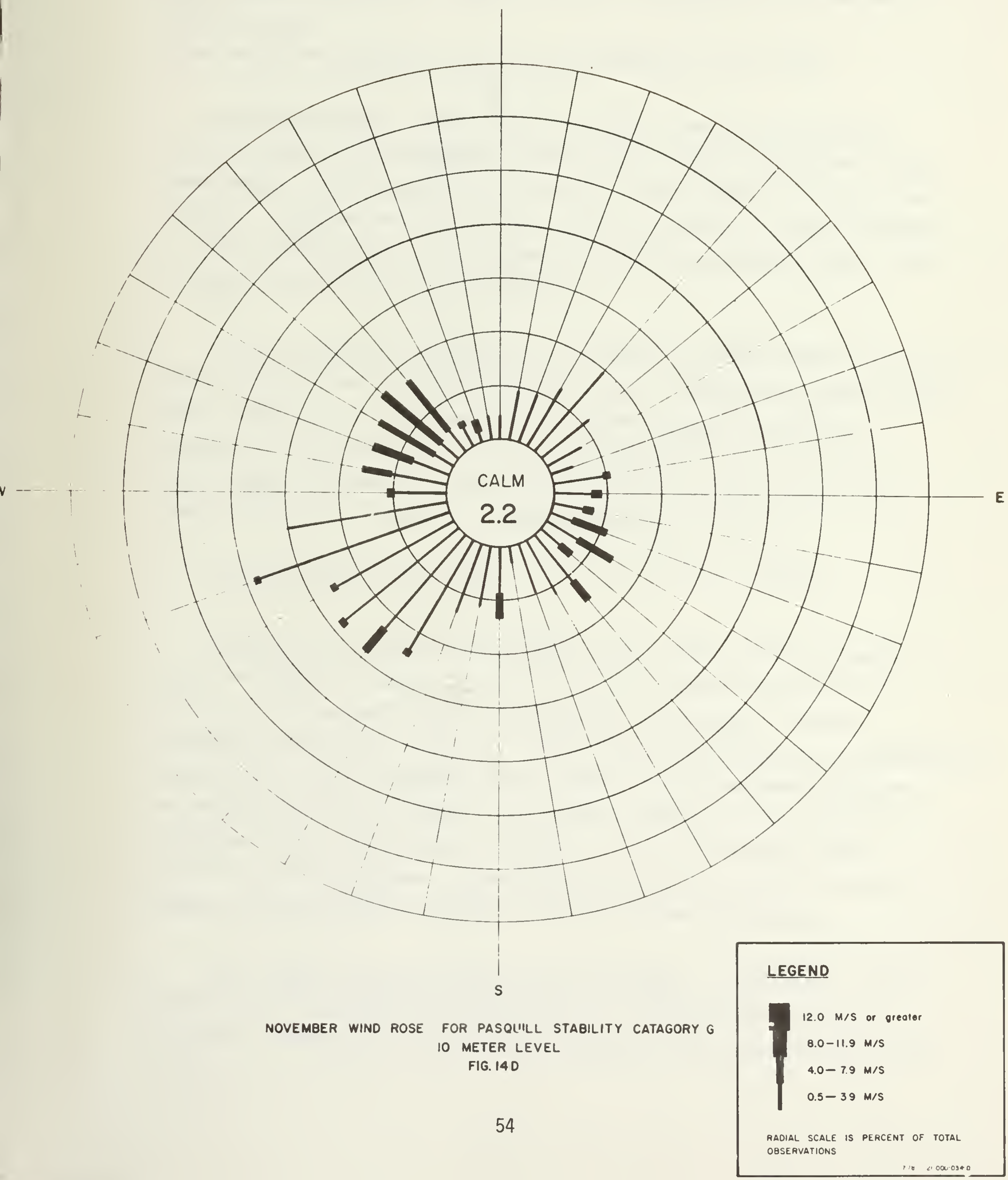


NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY E
10 METER LEVEL
FIG. 14 B





NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY F
10 METER LEVEL
FIG. 14 C



NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY G
10 METER LEVEL
FIG. 14D

During category E conditions, wind speeds show a marked decrease, averaging nearly 5 ms^{-1}. Northwesterly and southeasterly winds are the most common and have the highest speeds. Northeasterly and southerly winds are the
occur much less frequently than during category D conditions.

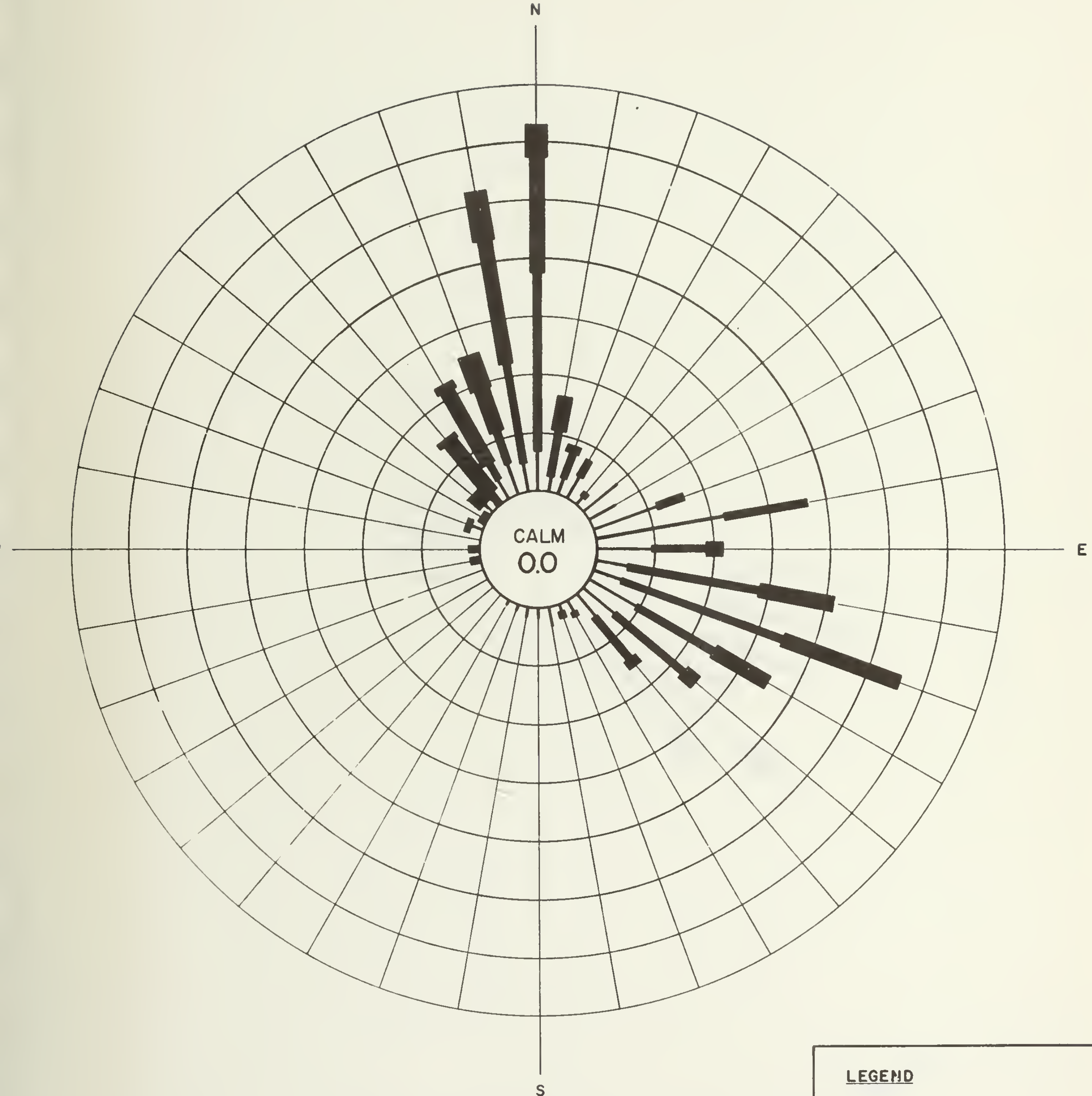
During category F conditions, wind speeds decrease, averaging nearly 4.0 ms^{-1}. Northwesterly, southeasterly, and southwesterly winds predominate. Northeasterly winds are the least common, as well as the lightest. Southwesterly winds also tend to be light; the high frequency of light southwesterly winds suggests a possible drainage effect. The strongest winds are from the southeast.

During category G conditions, wind speeds average between 2 and 3 ms^{-1}; winds above 4.0 ms^{-1} are rare. In this case, southwesterly winds are the most common and are very light. A secondary frequency maximum is observed for southeasterly winds; other wind directions occur with nearly equal frequencies. The high frequency of light southwesterly winds might be attributed to a drainage effect.

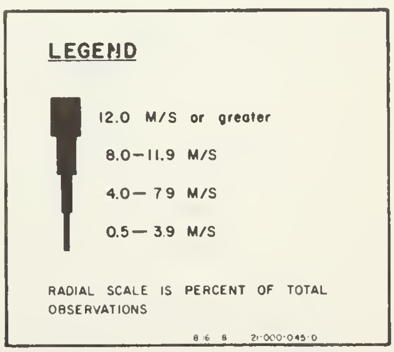
2. Winter Stability Wind Roses

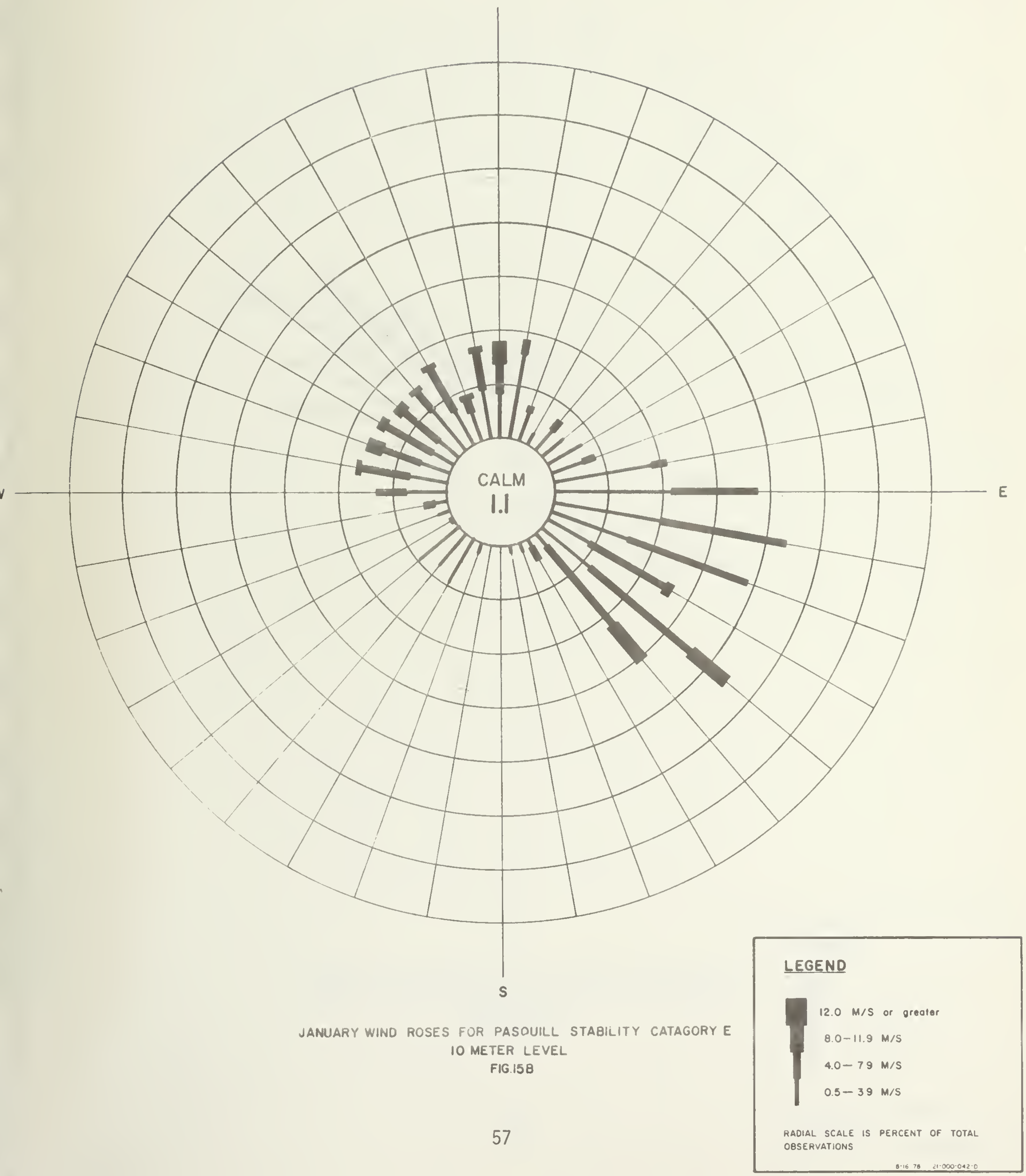
Figures 15A through 15D show January wind roses at the ten-meter level for stability categories D, E, F, and G, which represent the variation of winds with stability observed during winter. During category D conditions, nearly all winds are northerly and east-southeasterly; these are also the strongest winds. Winds from the southwest quadrant and southerly winds are almost nonexistent. Speeds during category D conditions are usually between 4.0 and 11.9 ms^{-1}, and speeds above 12.0 ms^{-1} are not uncommon. Speeds below 4.0 ms^{-1} are fairly rare and usually are associated with winds from the northeast quadrant.

Wind speeds decrease markedly during category E conditions; nearly half of the wind speeds are below 4.0 ms^{-1}, and winds above 8.0 ms^{-1} are rare. Northwesterly and east-southeasterly winds predominate; these

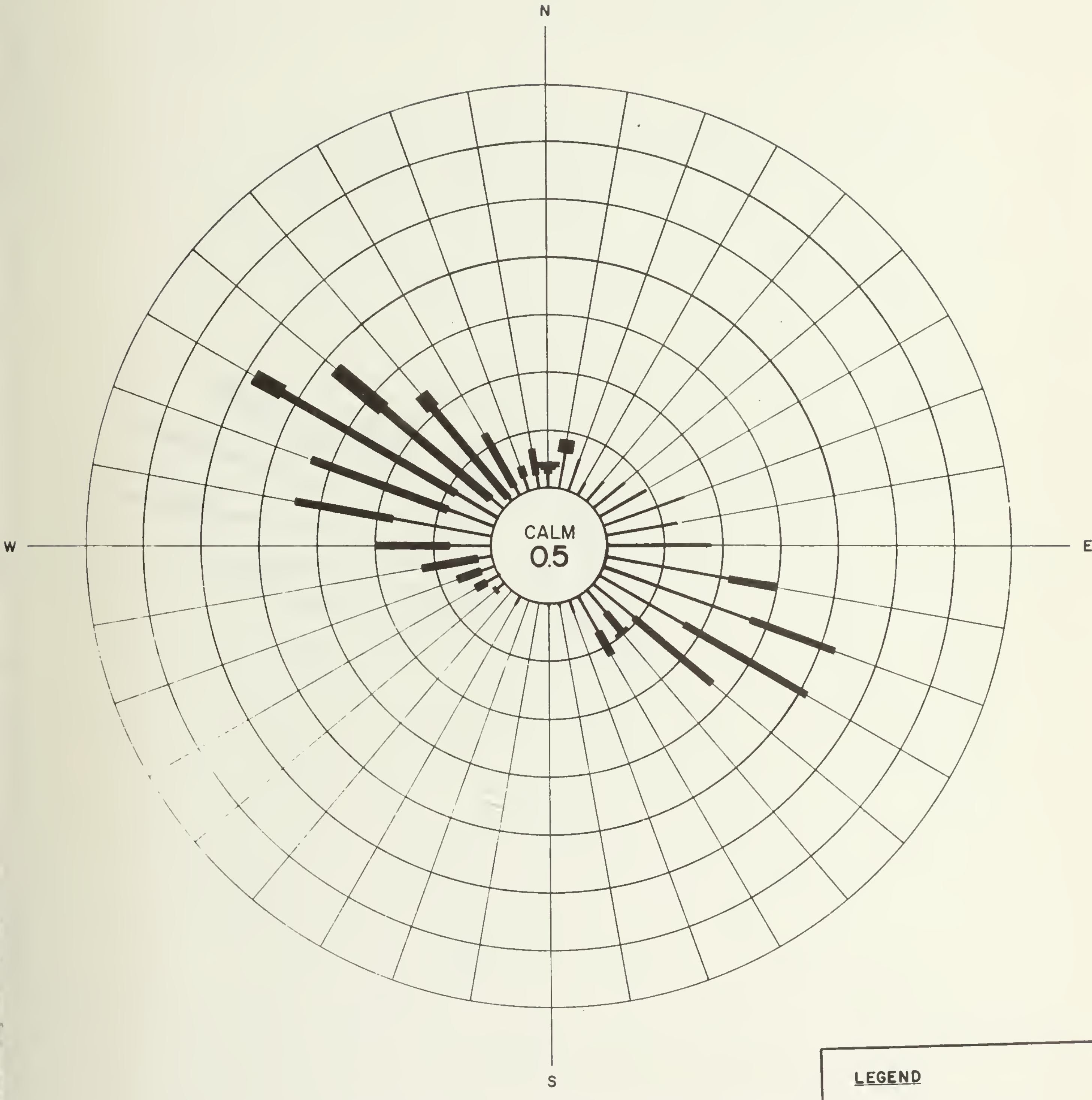


JANUARY WIND ROSES FOR PASQUILL STABILITY CATAGORY D
10 METER LEVEL
FIG15A

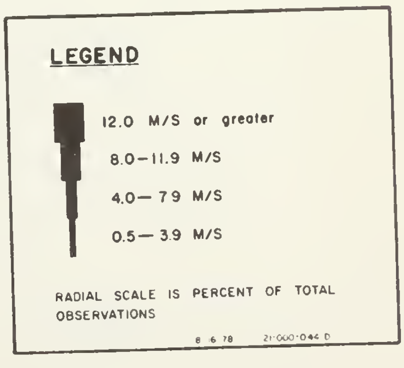


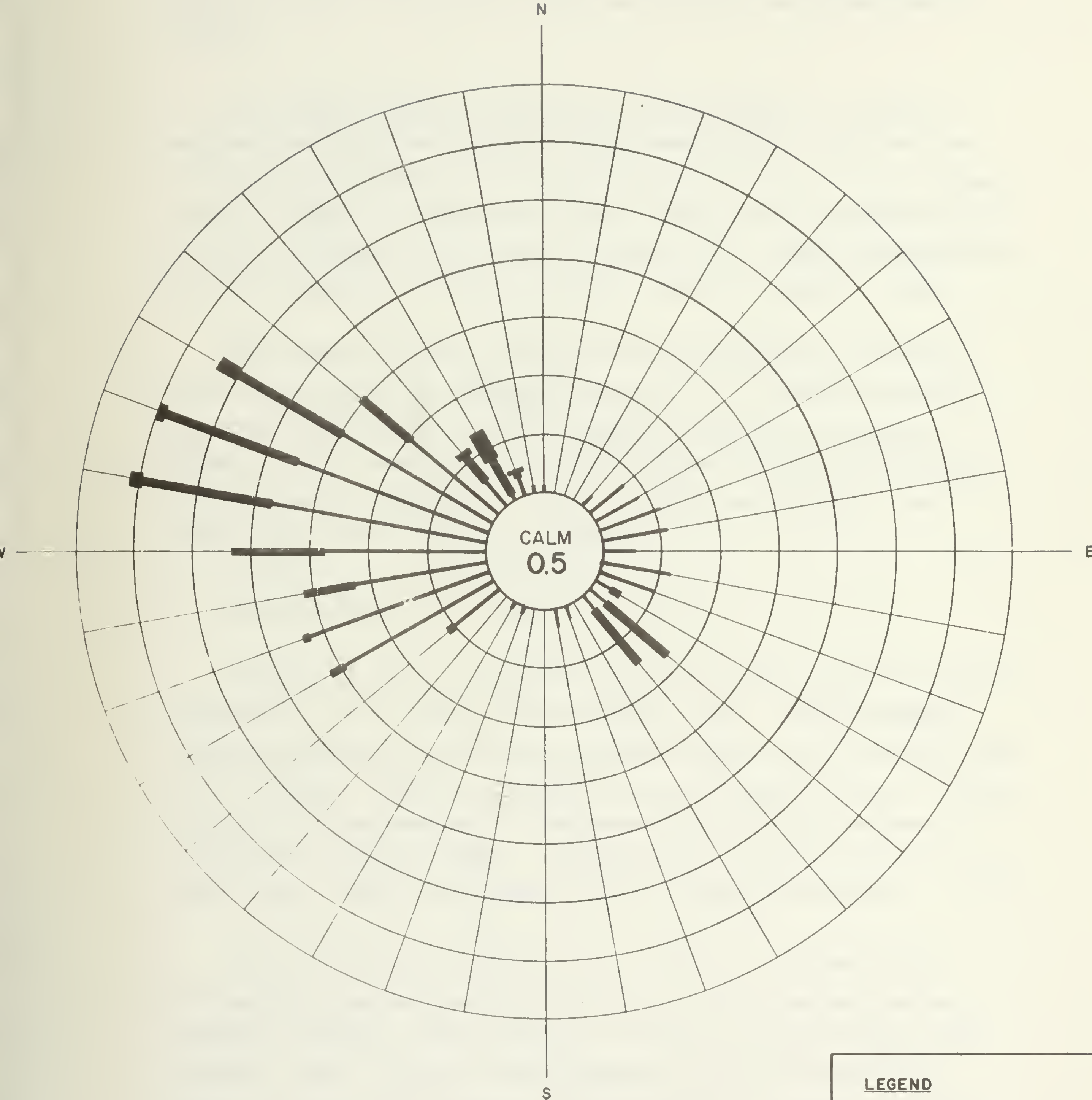


JANUARY WIND ROSES FOR PASQUILL STABILITY CATAGORY E
10 METER LEVEL
FIG.15B



JANUARY WIND ROSES FOR PASQUILL STABILITY CATAGORY F
10 METER LEVEL
FIG. 15C





JANUARY WIND ROSES FOR PASQUILL STABILITY CATAGORY G
10 METER LEVEL
FIG. 15D

LEGEND

12.0 M/S or greater
8.0—11.9 M/S
4.0— 7.9 M/S
0.5— 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS

6 6 78 21 060 043-0

winds are also the strongest. Southwesterly, southerly, and northeasterly winds are the least common and generally have speeds below 4.0 ms^{-1}.

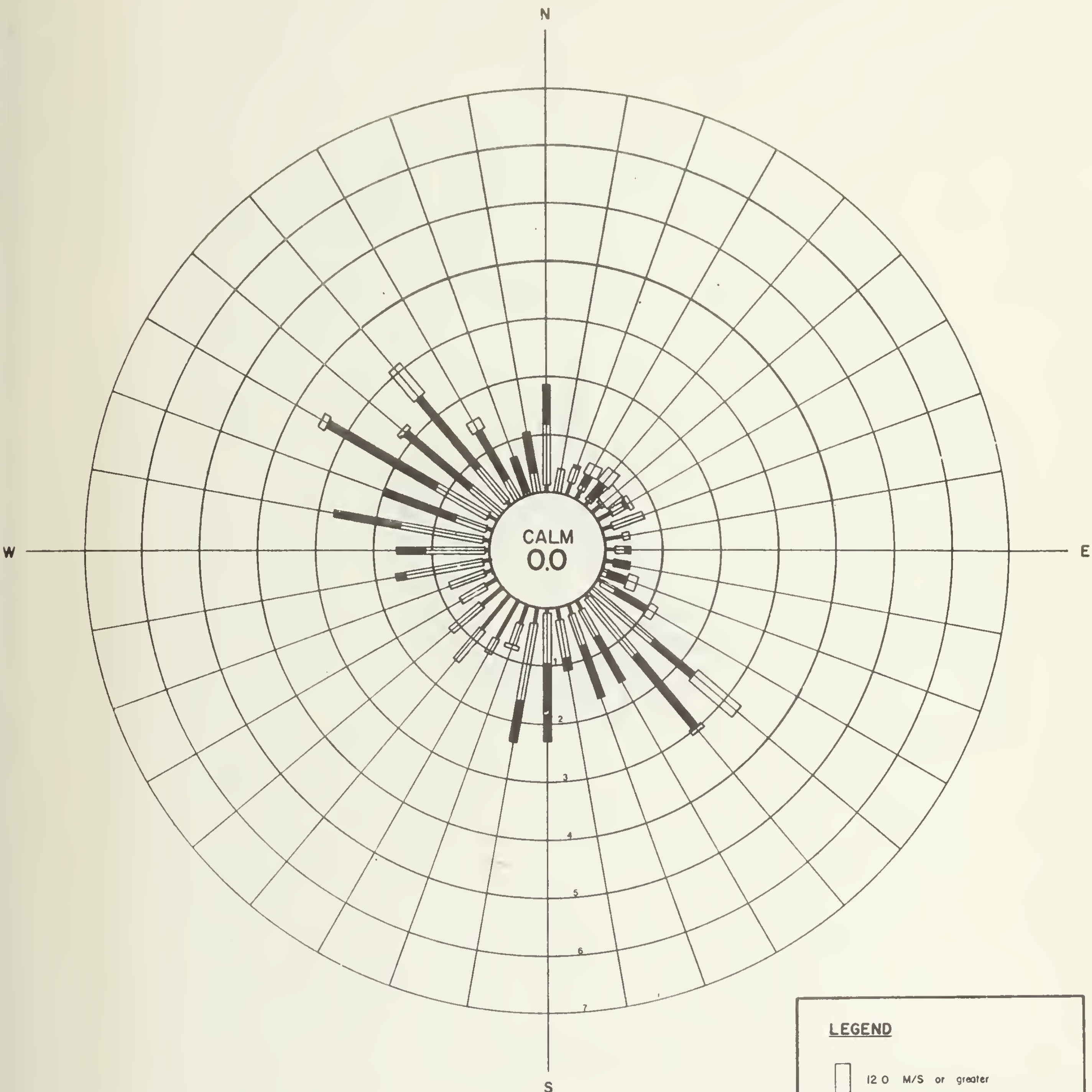
Wind speeds continue to decrease during category F conditions. West-northwest and east-southeast winds predominate; wind directions in the northwest quadrant are not distributed evenly as in the category E case. Southerly winds are very rare; winds from the northeast quadrant are infrequent and are usually below 4 ms^{-1}. West-northwest winds are the strongest, while east-southeast winds are generally light.

Wind speeds continue to decrease during category G conditions; about 75 percent of all speeds are below 4 ms^{-1}. Westerly winds predominate very strongly; a slight secondary maximum is observed for easterly winds. Northerly and southerly winds are almost nonexistent and are always below 4 ms^{-1}. Westerly winds, the strongest, have speeds below 4 ms^{-1} about half the time.

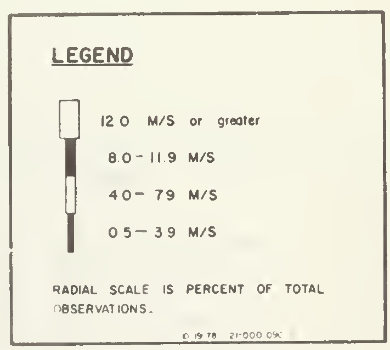
3. Spring Stability Wind Roses

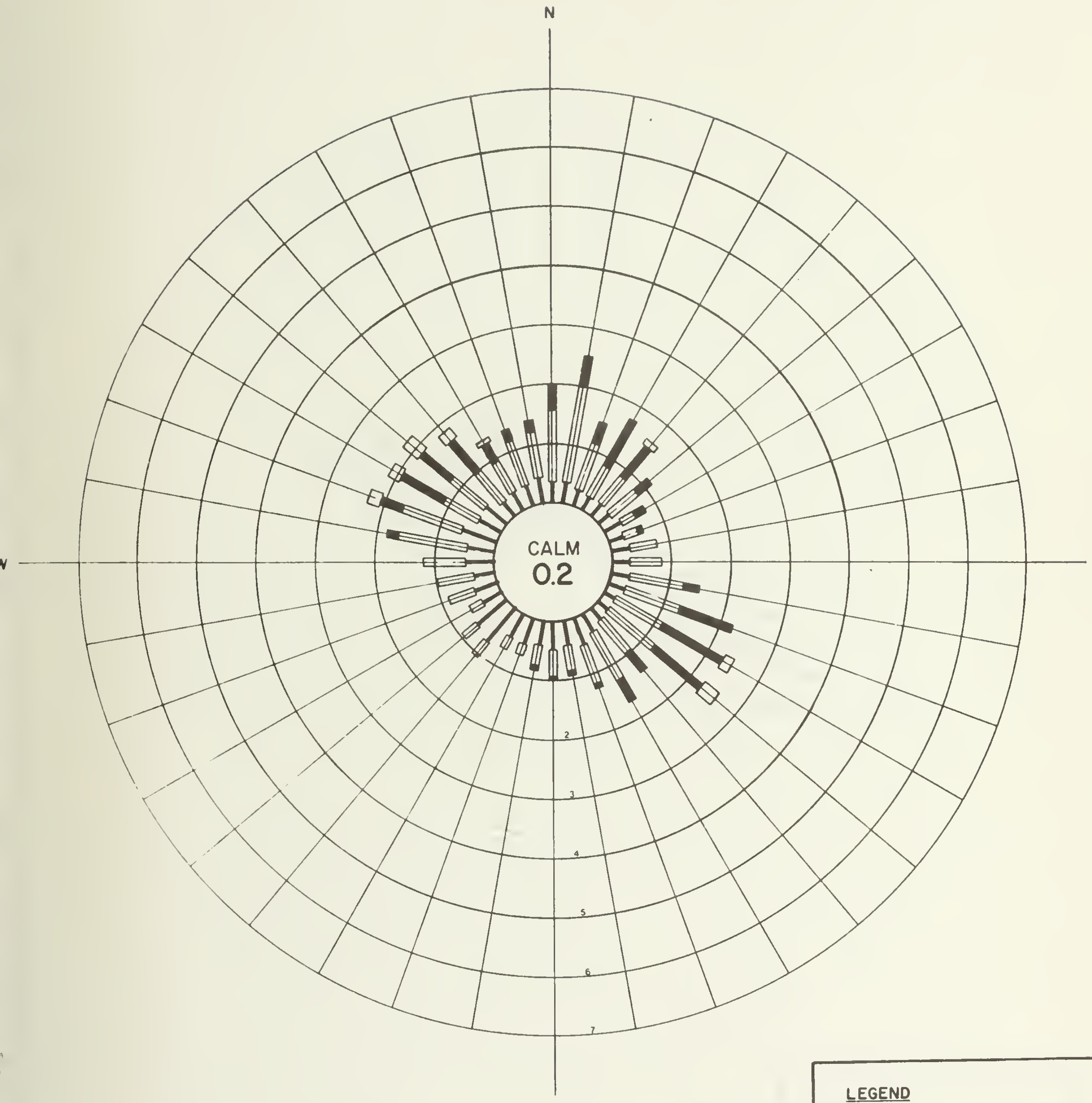
Figures 15E, 15F, 15G, and 15H show spring wind roses for stability categories C, D, E, and F at the ten-meter level. During category C conditions, speeds are very high, averaging nearly 7 ms^{-1}; speeds below 4 ms^{-1} are rare. Both the strongest and most common winds are from the northwest and the southeast. A secondary wind direction maximum is observed for southerly winds. Northeasterly and easterly winds are the least common, while the lightest winds are from the southwest.

During category D conditions, wind speeds are somewhat lower. Northwesterly and southeasterly winds occur most often and are the strongest; however, these directions are less pronounced than in the category C case. Easterly and southwesterly winds are the least common as well as the lightest, although most 10° intervals in these directions still accounted for about two percent of all winds.



SPRING WIND ROSE FOR PASQUILL STABILITY CATAGORY C
10 METER LEVEL
FIG. 15 E





SPRING WIND ROSE FOR PASQUILL STABILITY CATAGORY D
10 METER LEVEL
FIG. 15 F

LEGEND

12.0 M/S or greater
8.0 - 11.9 M/S
4.0 - 7.9 M/S
0.5 - 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.

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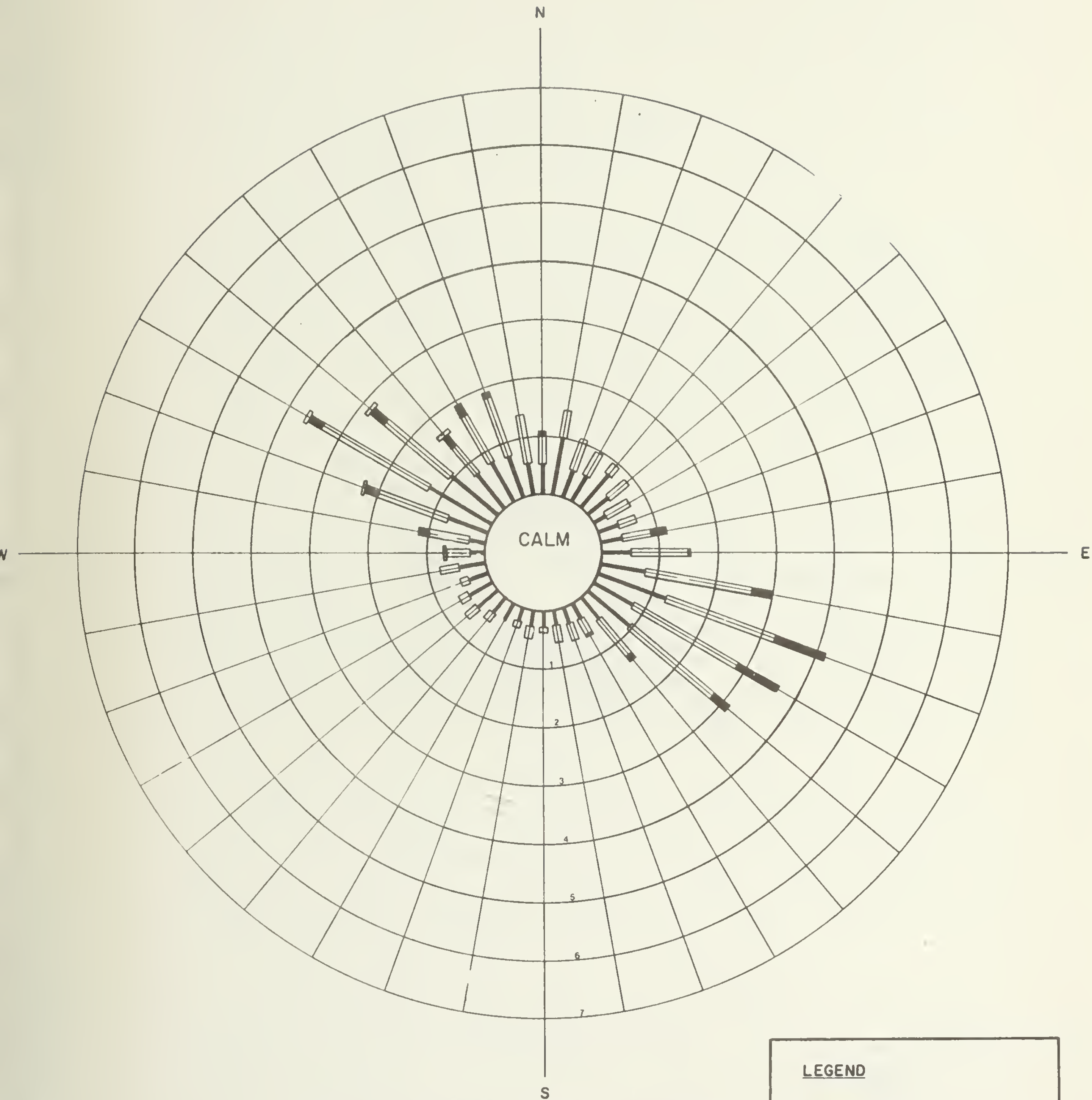
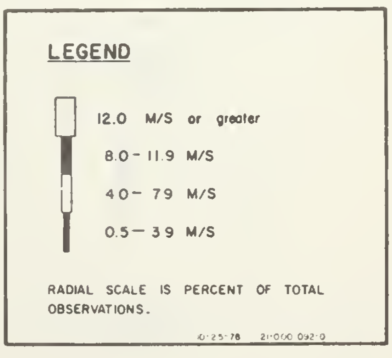
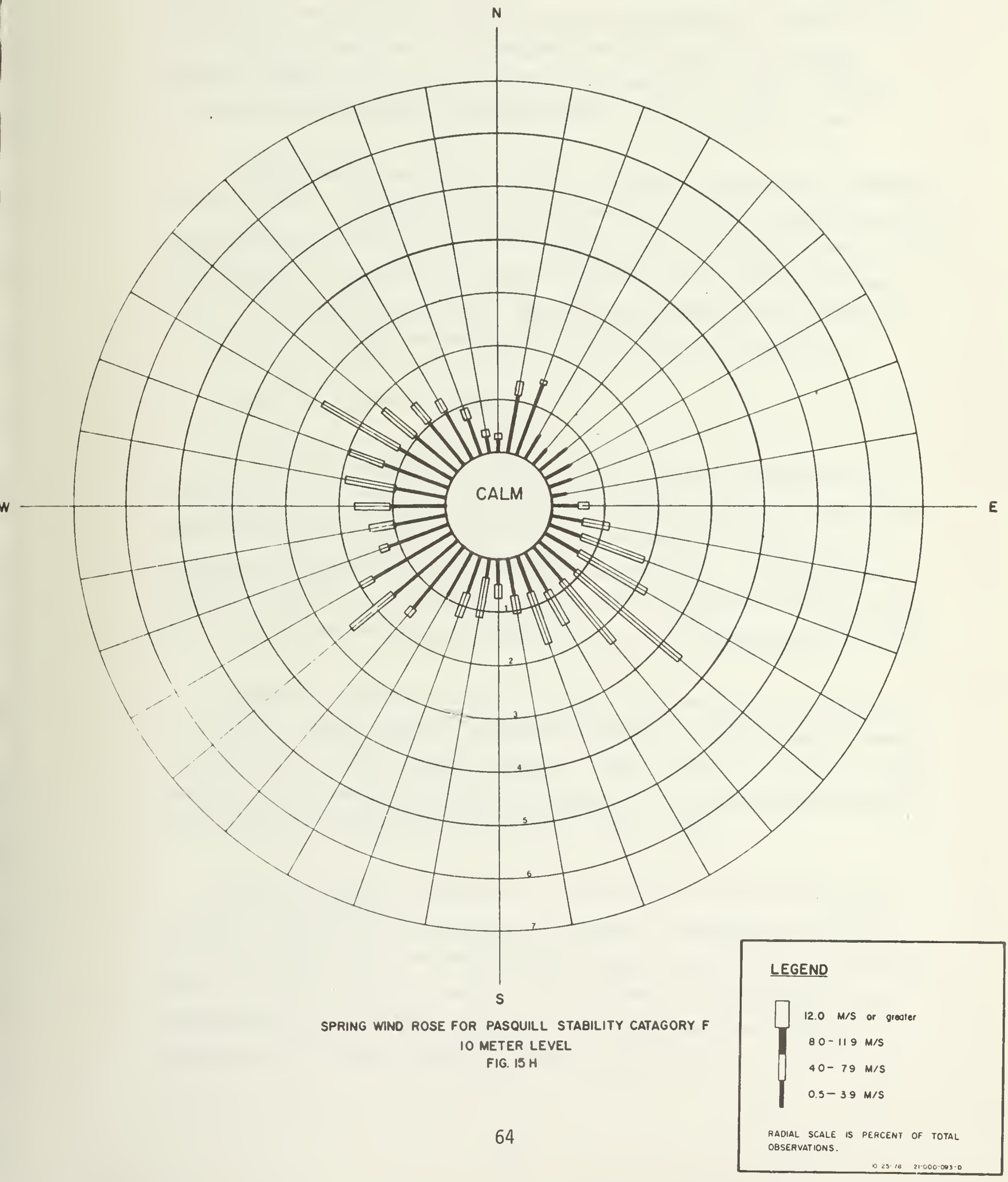


SPRING WIND ROSE FOR PASQUILL STABILITY CATAGORY E
10 METER LEVEL
FIG. 15 G





SPRING WIND ROSE FOR PASQUILL STABILITY CATAGORY F
10 METER LEVEL
FIG. 15 H

During category E conditions, wind speeds are lower, averaging nearly 5 ms^{-1}. Wind directions are similar to those observed during category D conditions; northwesterly and southeasterly winds are the most common as well as the strongest, while southerly and southwesterly winds are the least common and tend to be light. Frequent wind directions are more pronounced than in the category D case.

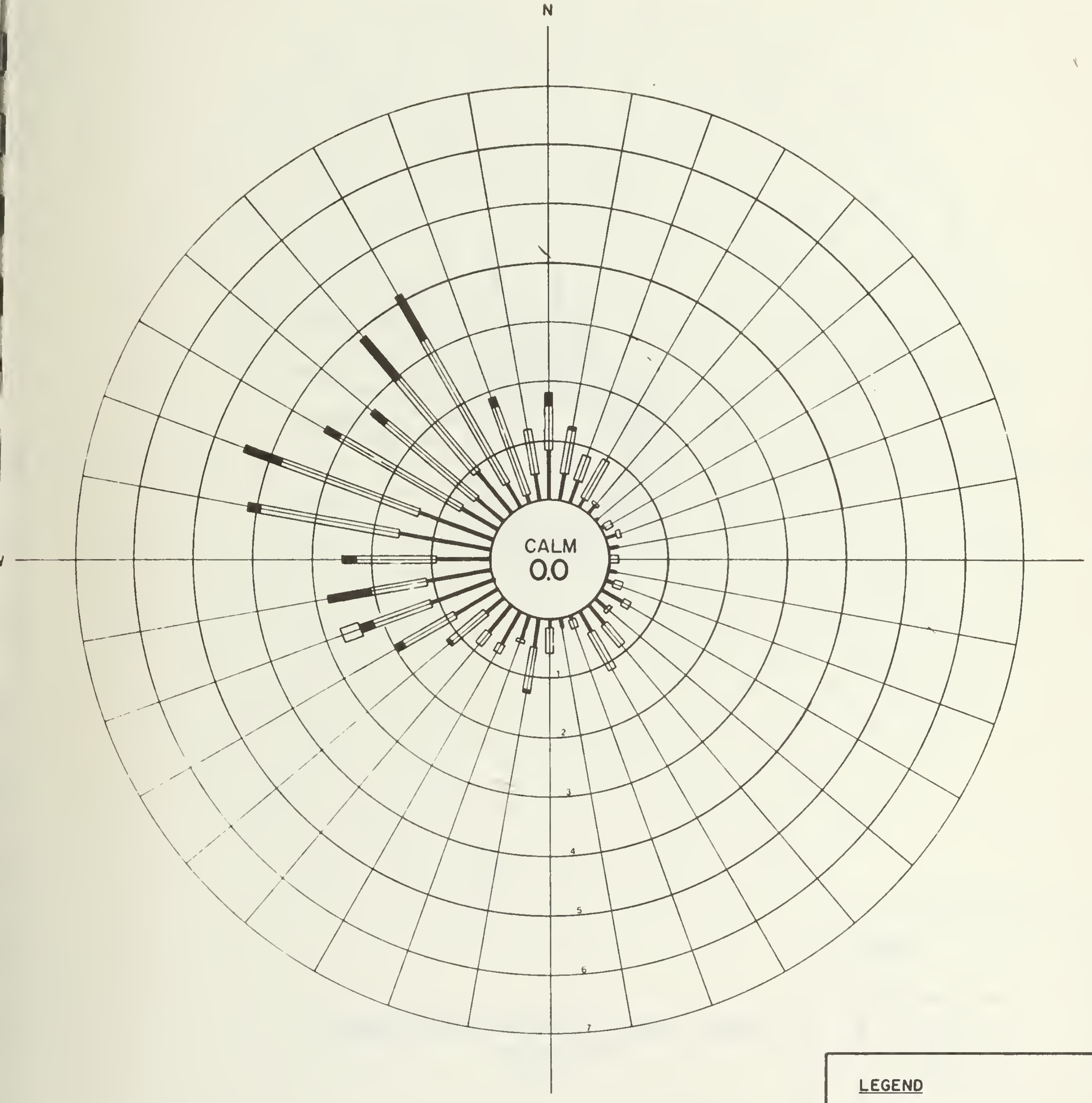
Wind speeds decrease again during category F conditions, averaging nearly 4 ms^{-1}. Southwesterly and southeasterly winds predominate, while northeasterly winds are the least common and are invariably below 4 ms^{-1}. Southwesterly winds are also light, suggesting that these winds may result from a drainage effect. Westerly and southeasterly winds are the strongest; speeds below 4 ms^{-1} occur nearly half the time.

4. Summer Stability Wind Roses

Figures 15I through 15L show summer wind roses for stability categories C, D, E, and F, respectively. During category C conditions, winds from the northwest quadrant are most common, as well as the strongest; speeds are usually between 4 and 12 ms^{-1}. Southerly and easterly winds are rare and are below 4 ms^{-1} about half the time they occur. Wind speeds during category C conditions average nearly 6 ms^{-1}.

Category D winds are similar to those observed during category C conditions. Winds from the northwest quadrant are most common; speeds are distributed fairly equally between 0 and 12 ms^{-1}. Winds from other quadrants occur with nearly equal frequencies. Southeasterly winds are the strongest; speeds are almost always above 4 ms^{-1}.

During category E conditions, a substantial wind speed decrease is noted, especially for southeasterly winds. Northwesterly winds are the strongest and the most common; speeds above 4 ms^{-1} occur about half the time. Secondary maxima are observed for southeasterly and northeasterly winds. Easterly winds and winds from the southwest quadrant are the least common and tend to be light.

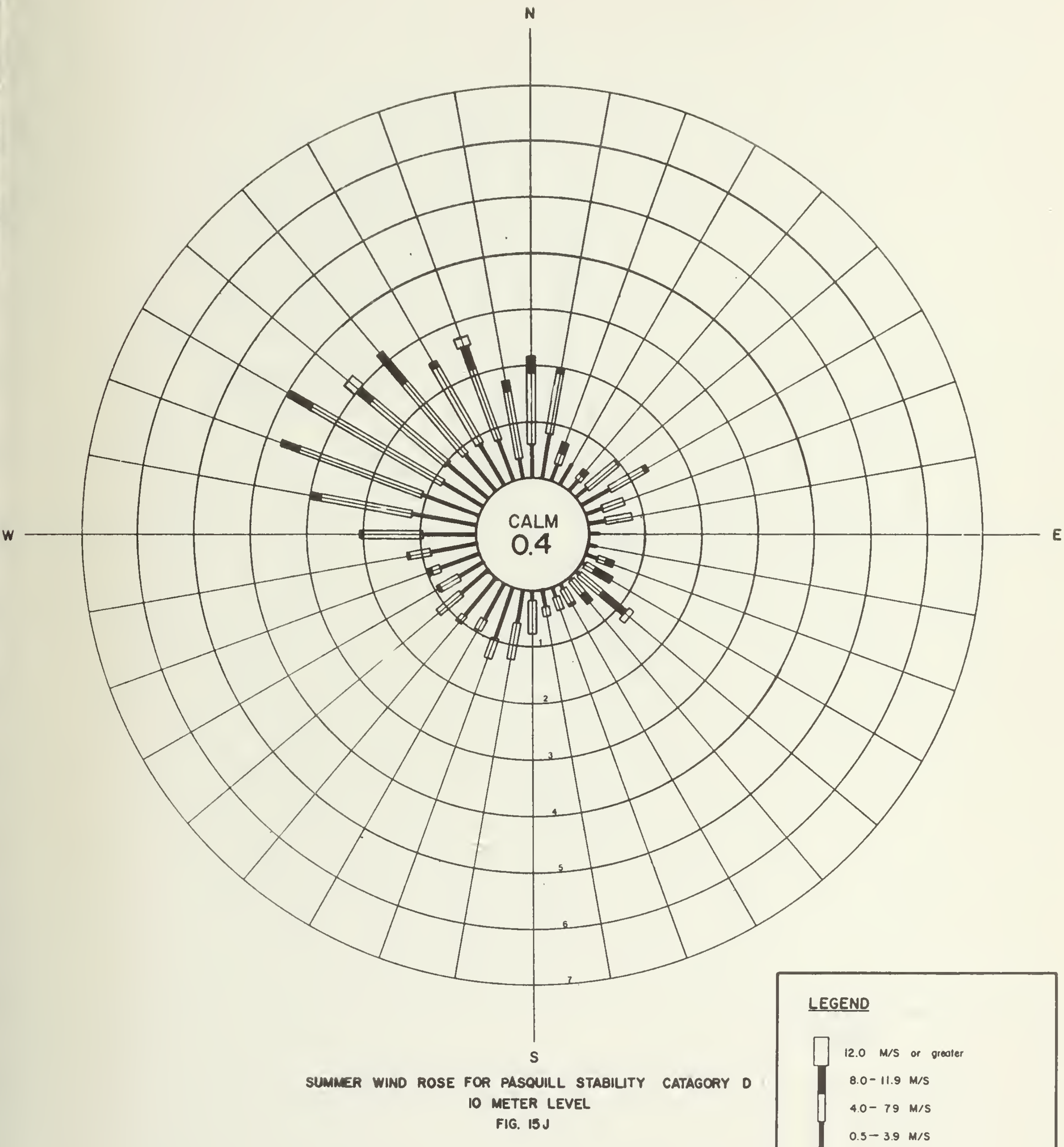


SUMMER WIND ROSE FOR PASQUILL STABILITY CATAGORY C
10 METER LEVEL
FIG. 15 I

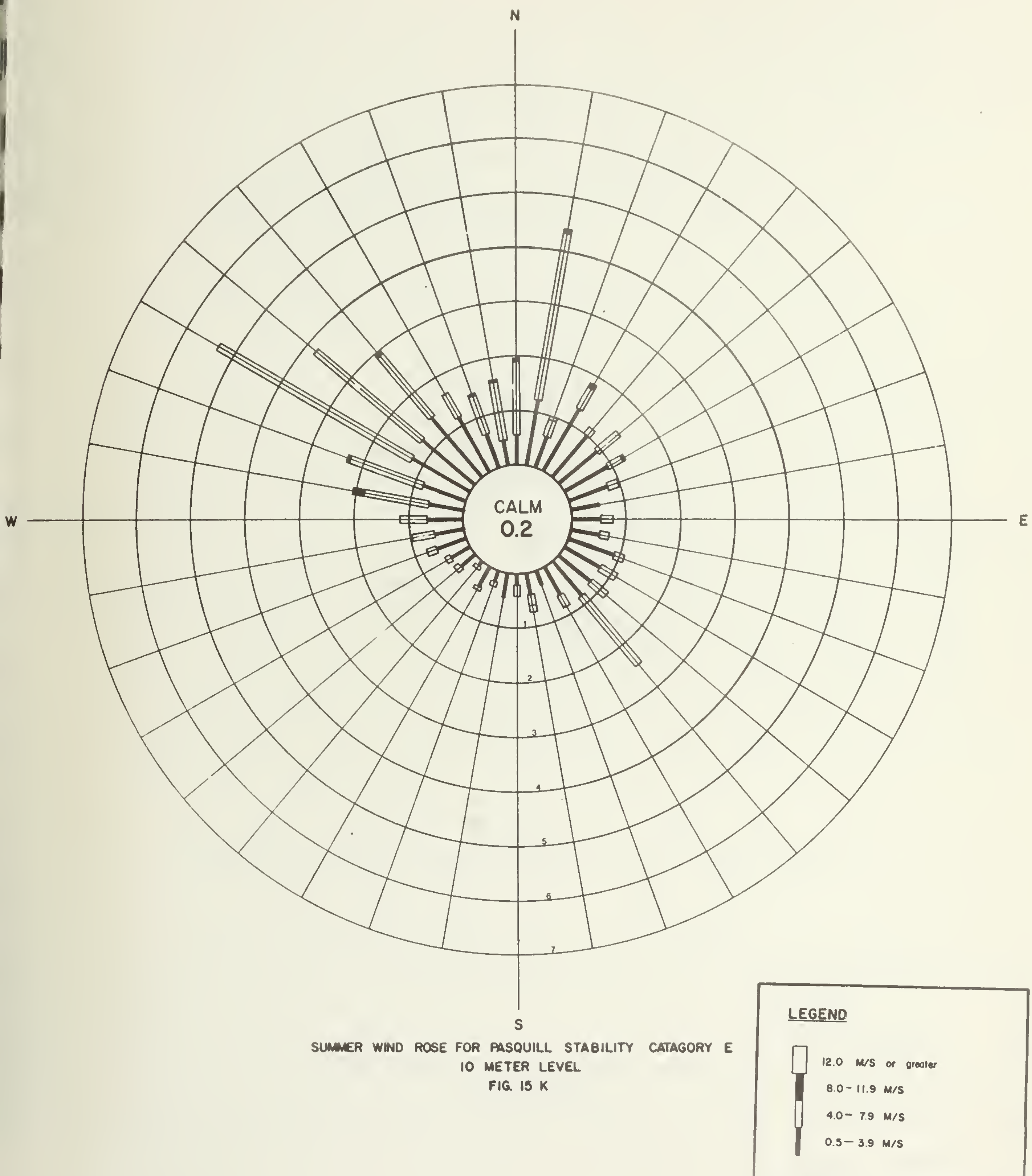
LEGEND

12.0 M/S or greater
8.0 – 11.9 M/S
4.0 – 7.9 M/S
0.5 – 3.9 M/S

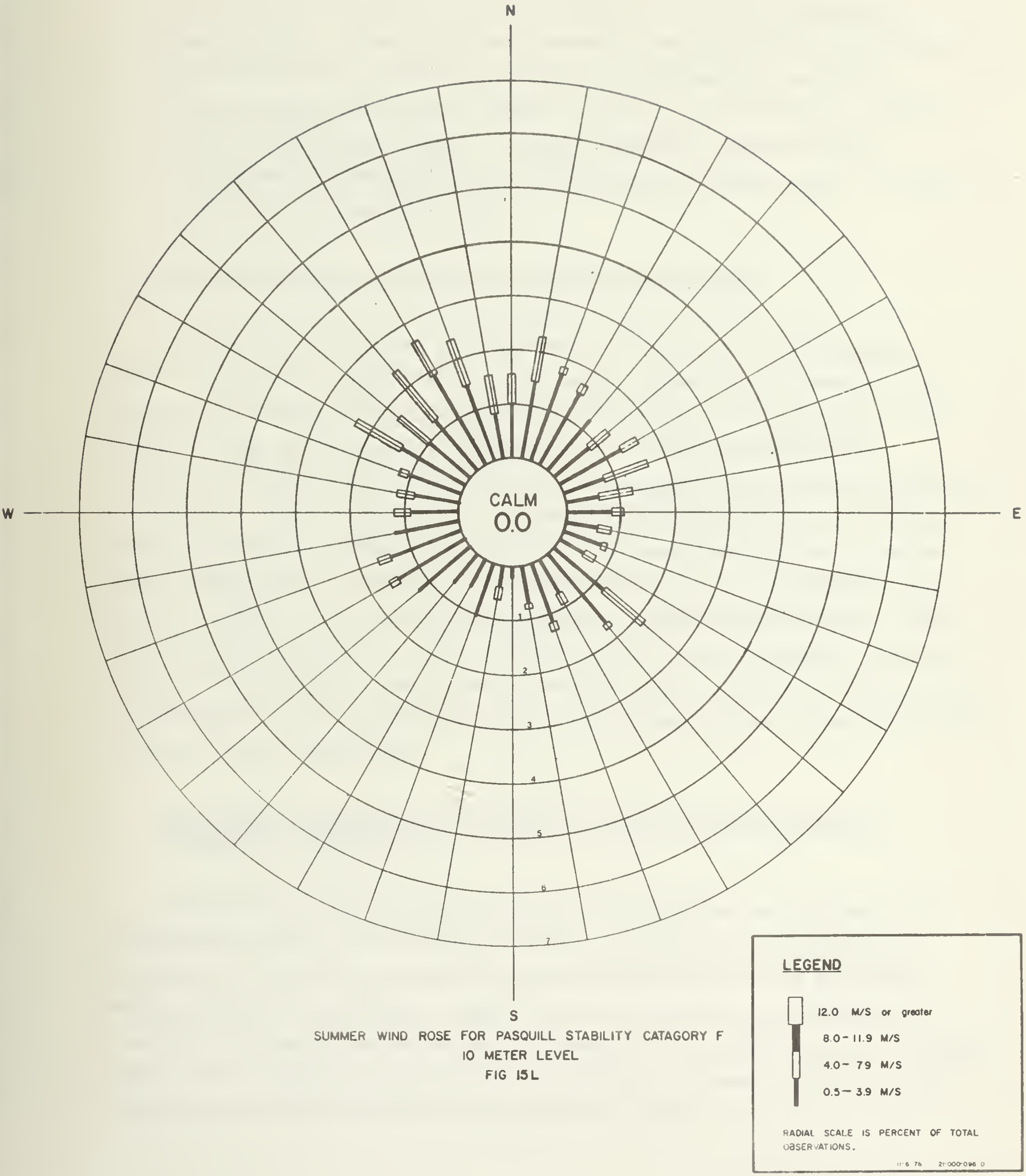
RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.



SUMMER WIND ROSE FOR PASQUILL STABILITY CATAGORY D
10 METER LEVEL
FIG. 15J



SUMMER WIND ROSE FOR PASQUILL STABILITY CATAGORY E
10 METER LEVEL
FIG. 15 K



SUMMER WIND ROSE FOR PASQUILL STABILITY CATAGORY F
10 METER LEVEL
FIG 15L

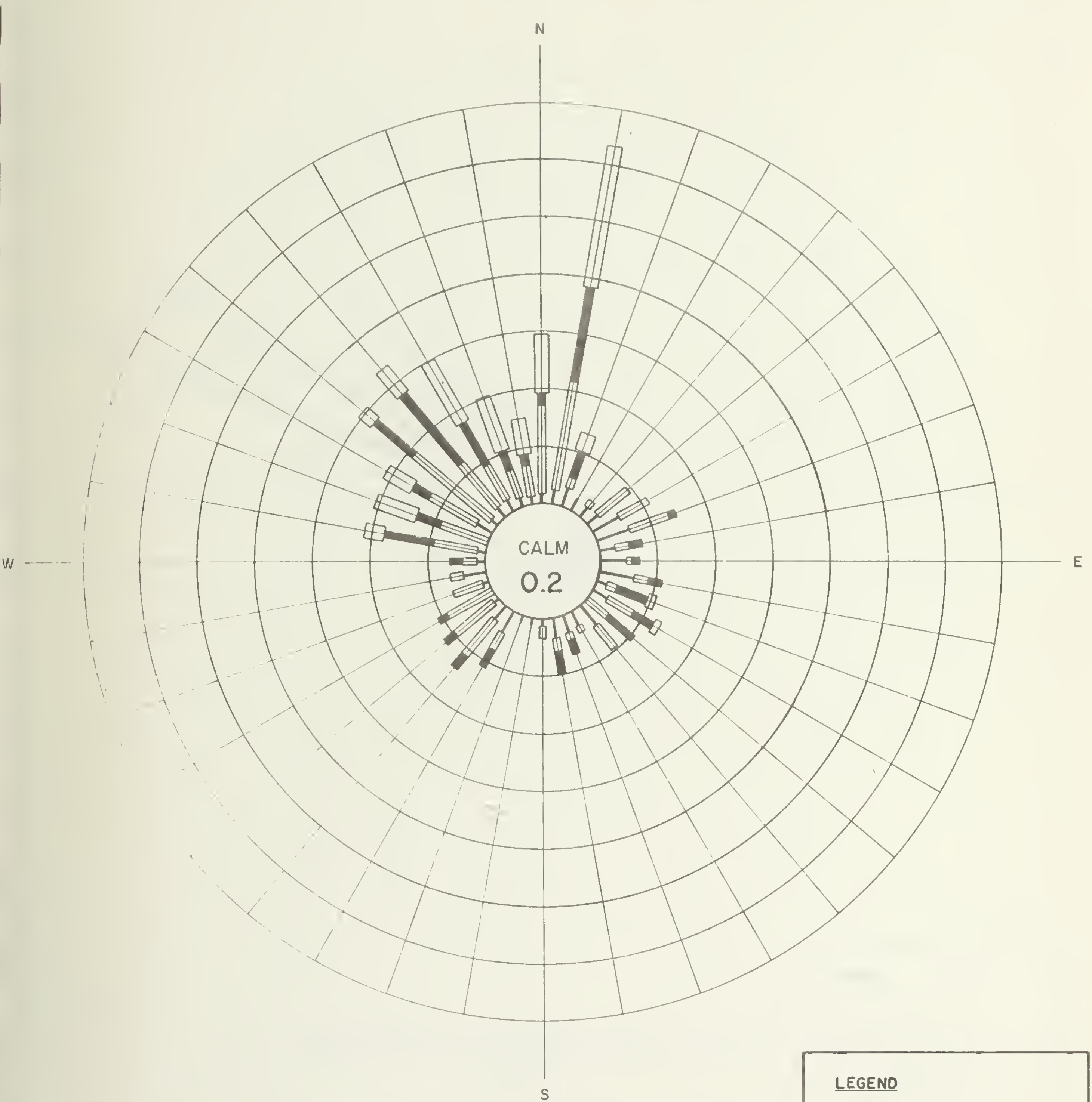
Wind speeds decrease during category F conditions, averaging nearly 3 ms^{-1}. Wind direction frequencies are distributed more equally than during other stability categories. Northwesterly and southeasterly winds are the most common as well as the strongest; southerly winds are the least common. A slight secondary direction maxima is observed for southwesterly and northeasterly winds; winds from these directions are generally light.

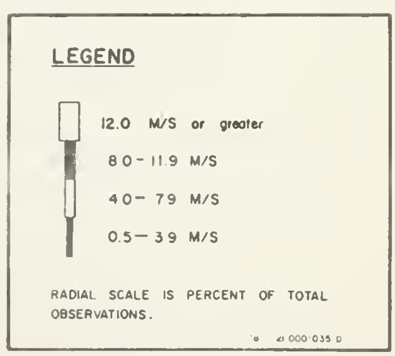
H. Comparison of Ten- and 100-Meter Level Wind Patterns

Figures 16A through 16D show November wind roses for the 100-meter level for stability categories D, E, F, and G. These can be compared with Figures 14A through 14D, which show these wind roses for the ten-meter level. Overall, winds at the ten-and 100-meter levels show great directional similarity, although wind directions at the two levels can differ substantially at any given time. Wind direction differences are negligible over the long term except during category G conditions. In these cases, winds at the ten-meter level can be influenced by drainage effects, while the 100-meter level may be too high to be influenced by terrain-induced drainage effects. Wind speeds at the two levels differ considerably; this was discussed in Section II. Speeds at the 100-meter level tend to decrease with increasing stability, but this decrease is less pronounced than at the ten-meter level, especially during category F and G conditions.

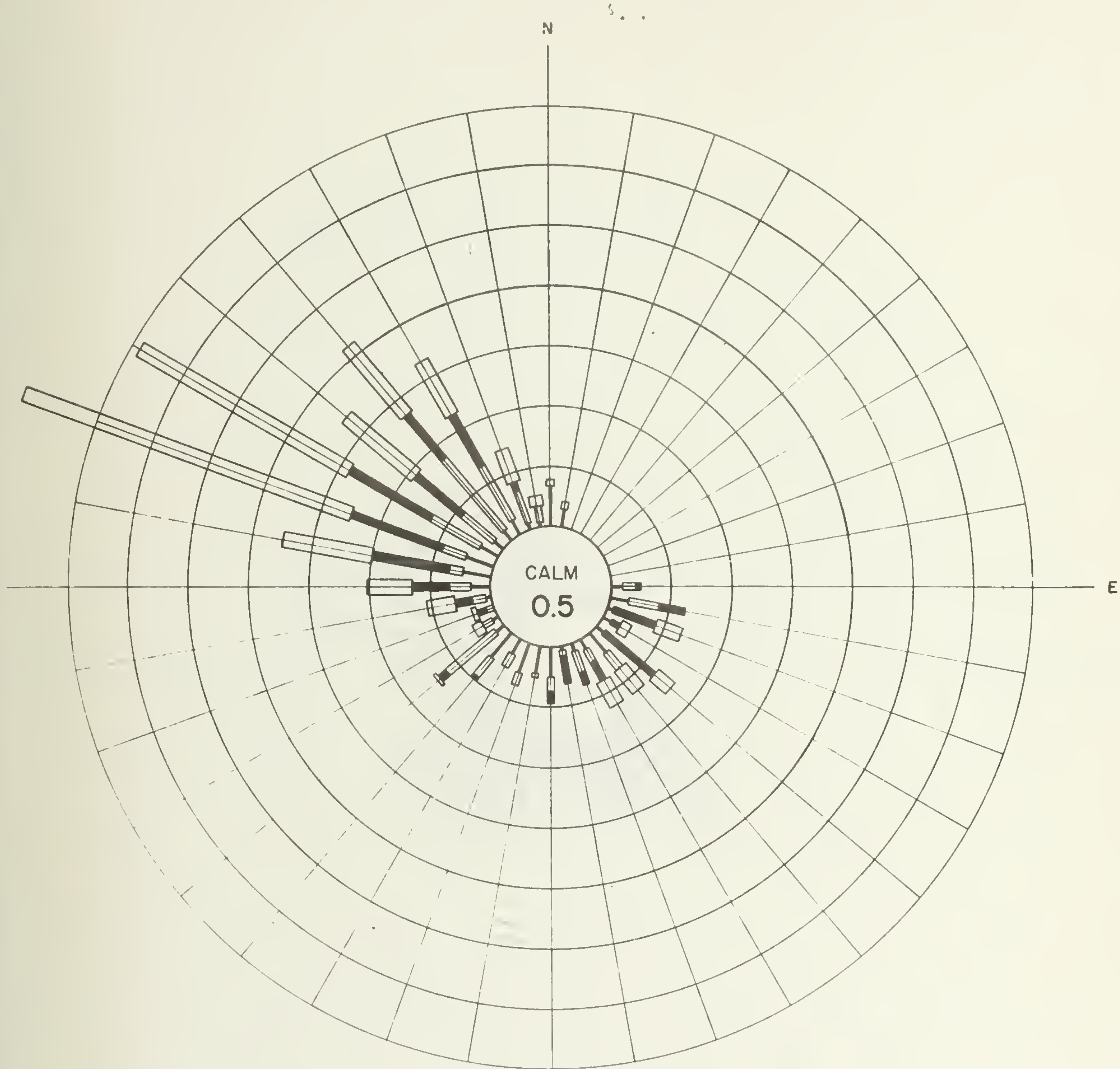
I. Difference in Ten-Meter and 100-Meter Wind Directions Related to Atmospheric Stability

The vertical shear of the horizontal wind direction can influence the atmosphere's ability to disperse pollutants, as well as the transport of pollutants. This section examines the absolute wind direction differences between the ten- and 100-meter tower levels as a function of atmospheric stability. It should be emphasized that these are average absolute differences rather than average differences; this distinction is shown in the following example where two data sets show the following values:





NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY D
100 METER LEVEL
FIG. 15 A



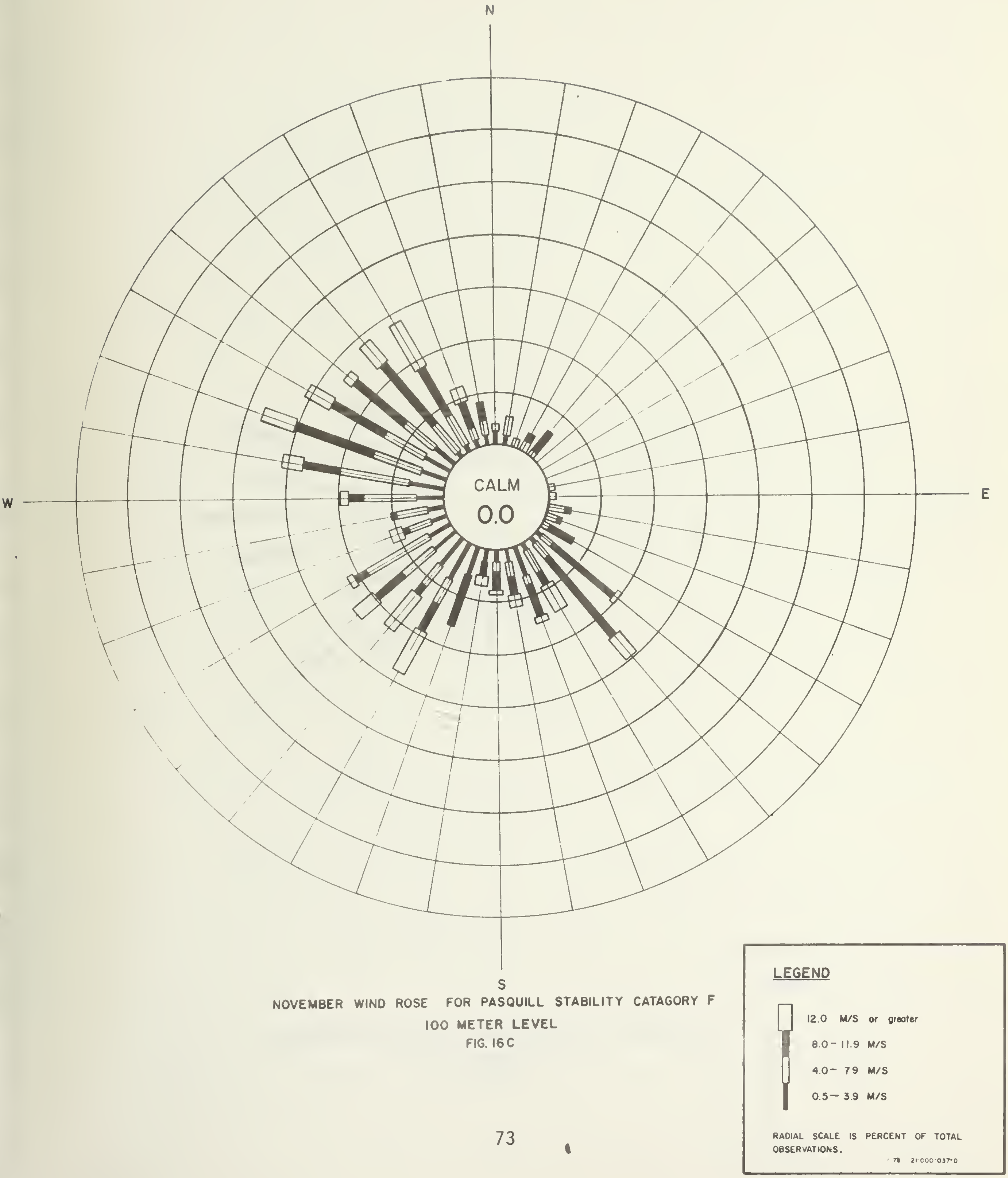
NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY E
100 METER LEVEL
FIG. 16 B

LEGEND

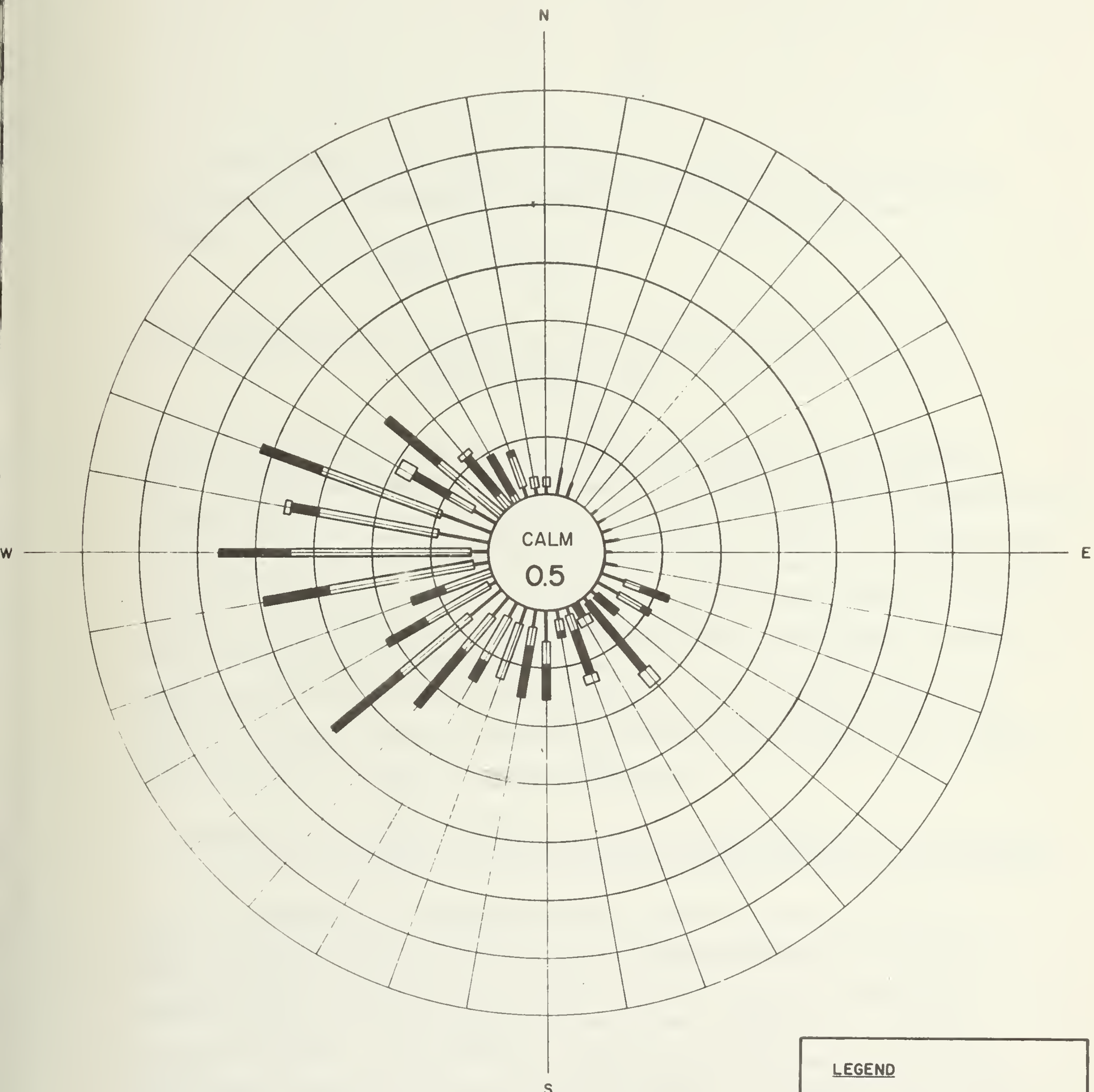
12.0 M/S or greater
8.0 – 11.9 M/S
4.0 – 7.9 M/S
0.5 – 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.

7 78 21·000 036·0



NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY F
100 METER LEVEL
FIG. 16C



NOVEMBER WIND ROSE FOR PASQUILL STABILITY CATAGORY G
100 METER LEVEL
FIG. 16 D

LEGEND

12.0 M/S or greater
8.0 – 11.9 M/S
4.0 – 79 M/S
0.5 – 3.9 M/S

RADIAL SCALE IS PERCENT OF TOTAL OBSERVATIONS.

i	A_i	B_i
1	5	10
2	10	5
3	5	0
4	0	5

In this case, the average difference is 0, but the average absolute difference is 5. The average difference was calculated using the formula

$$\overline{A_i - B_i} = \frac{\sum A_i - B_i}{N} ;$$

the average absolute difference was calculated using the formula

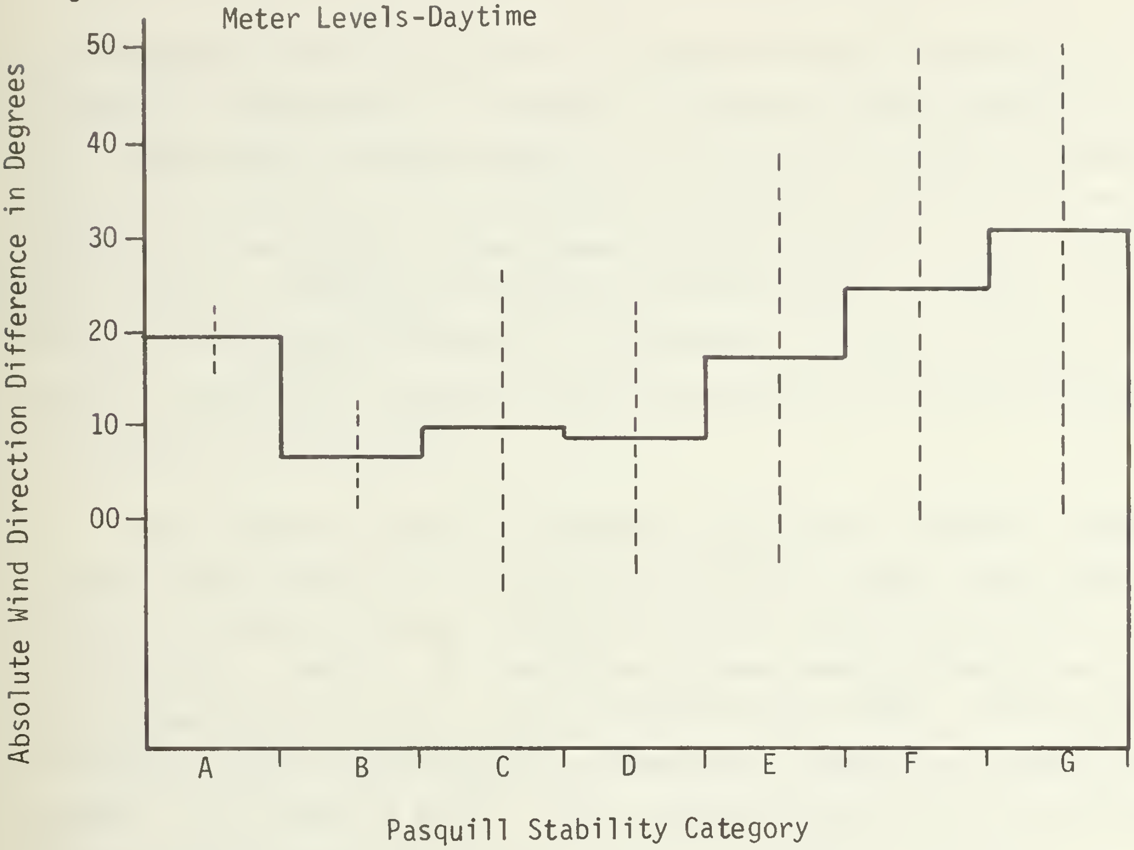
$$\overline{|A_i - B_i|} = \frac{\sum |A_i - B_i|}{N} .$$

Figure 17 shows these direction differences during daytime and nighttime hours. These direction differences show no real trends during thermodynamically unstable cases (stability categories A, B, and C). However, a definite trend is observed during neutral and stable cases. The daytime direction difference rises from 8° during category D conditions up to 31° during category G conditions. The nighttime direction difference ranges from 6° during category D conditions to 39° during category G conditions. It is evident that this absolute wind direction difference increases as the atmosphere becomes more stable. The high standard deviations (incidated by the dotted lines) suggest high variability in these direction differences.

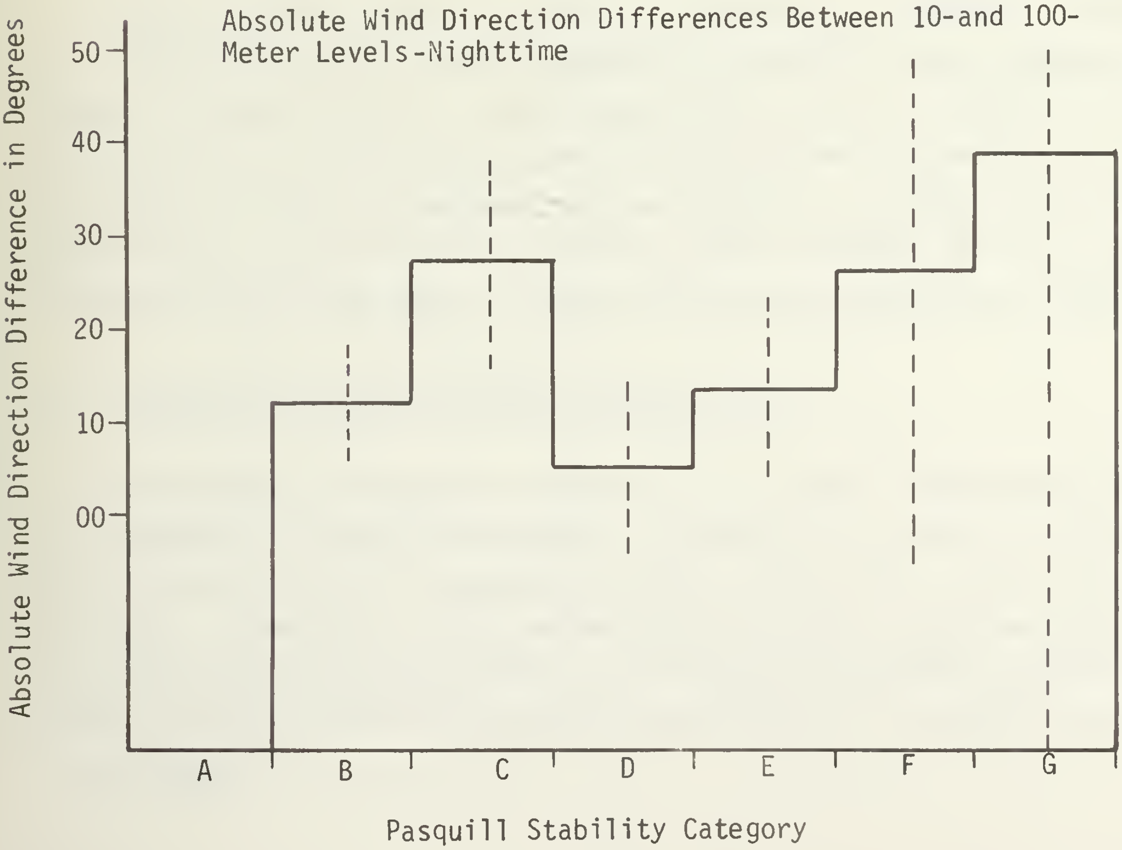
J. Comparison of Glasgow Air Force Base and Glasgow NWS Stability Categories

It is necessary to compare atmospheric stability characteristics at GAFB and Glasgow NWS to justify the use of Glasgow NWS data for describing GAFB stability characteristics. This is desirable because Glasgow NWS rawinsonde data is available for many years, while GAFB data is available for only one year. This comparison is made using data from both locations from October through June and by describing stability categories observed at GAFB when ceratin categories are observed at Glasgow NWS. There is one problem with this method; the stability category at GAFB is determined by

Figure 17.--Absolute Wind Direction Differences Between 10-and 100-Meter Levels-Daytime



Absolute Wind Direction Differences Between 10-and 100-Meter Levels-Nighttime



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the temperature difference across the constant height difference of 90 meters, corresponding to a pressure difference of about ten millibars. In a Glasgow NWS rawinsonde observation, the pressure difference between the surface pressure level and the next significant pressure level varies from two to over 100 mb. Since temperature does not always vary linearly with height, a comparison of stability between the two locations is valid only if the pressure differences at Glasgow NWS is close to 10 mb. In this study, a comparision is made only when the pressure difference at Glasgow NWS is between 8.5 and 11.5 mb.

Figure 18A shows stability categories observed at GAFB when categories D, E, and F were observed at Glasgow NWS at 000 GMT (category G was never observed, and categories A, B, and C were not observed often enough to warrant a comparison). Overall, the comparison is good; when category D was observed at Glasgow NWS, categories D and E were observed at GAFB. Note than when categories E and F were observed at Glasgow NWS, conditions tended to be somewhat less stable at GAFB. Still, atmospheric stabilities at GAFB and Glasgow NWS seldom differed by more than one category at 000 GMT.

Figure 18B shows stability categories observed at GAFB when categories D, E, F, and G were observed at Glasgow NWS at 1200 GMT. Again, the comparison is good; in most cases, the same categories were observed at both locations, and stabilities at the two locations rarely differed by more than one category. The stability similarity between the two locations is slightly better at 1200 GMT than at 000 GMT. This analysis seems to support the use of long-term Glasgow NWS rawinsonde data to infer stability characteristics at GAFB.

K. Glasgow NWS Inversion Height Characteristics

In atmospheric dispersion studies, it is of great importance to know the frequency of inversion formation. An inversion is a layer of the atmosphere through which the temperature increases with height, rather than decreases. Depending on other meteorological factors, inversion layers at times can cause high ground level concentrations of airborne pollutants. The height of these inversion layers above ground also can influence the dispersion of pollutants.

Figure 18A.--Observed Pasquill Stability Categories at Glasgow AFB Given A Stability Category at Glasgow NWS 0000 GMT

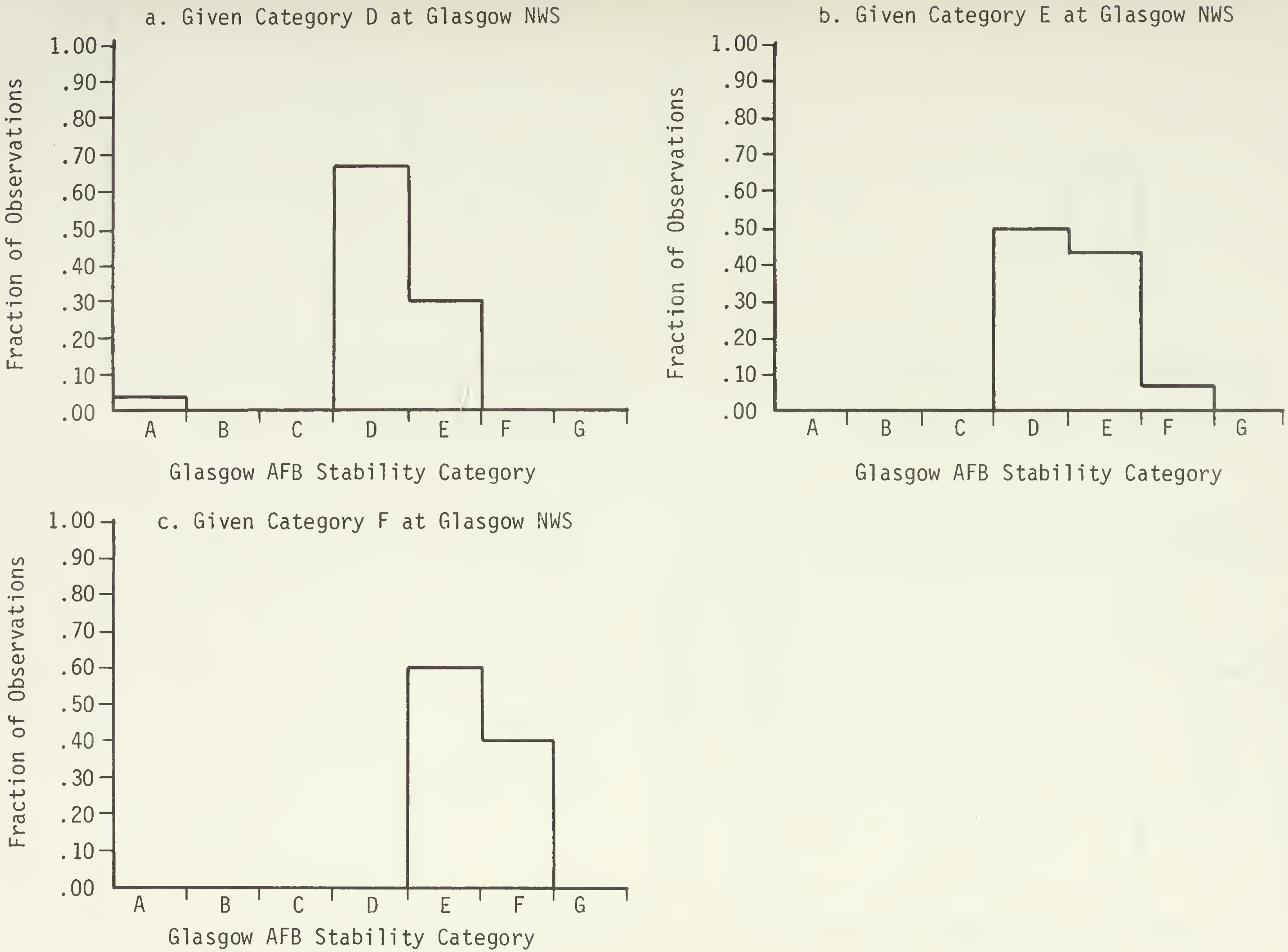

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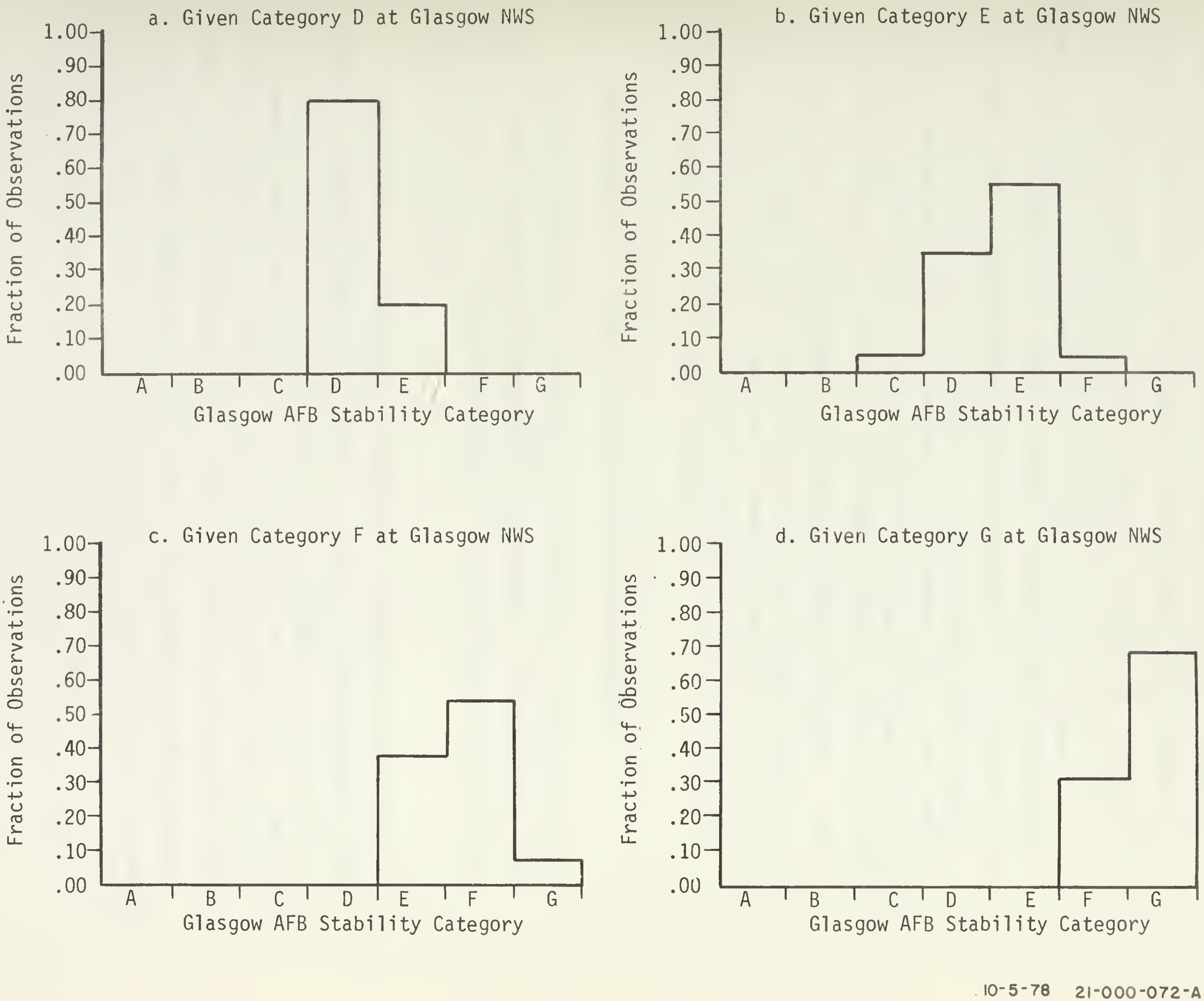
Figure 18B.--Observed Pasquill Stability Categories at Glasgow AFB Given a Stability Category at Glasgow NWS 1200 GMT



Inversions occur very frequently at Glasgow, in spite of the lack of complex terrain features and the windy climate. At least one inversion layer was found within 150 mb (1500 M) of the surface in 81.5 percent of the 0000 GMT observations and in 96.8 percent of the 1200 GMT observations. Figures 19A and 19B show frequency distributions for the height of the lowest inversion layer above ground for 0000 and 1200 GMT, respectively. At 0000 GMT, 43 percent of the lowest detected inversions were surface-based; this means that a surface-based inversion was observed in 43 percent of the cases in which inversions were present. It does not mean that a surface-based inversion was found in 43 percent of all observations. Base heights of between 0 and 80 mb were common, indicating frequent subsidence inversions. At 1200 GMT, however, 84 percent of the lowest inversions were surface-based, indicating a very high incidence of nocturnal radiation inversions. Other base heights between 0 and 80 mb occurred with nearly equal frequencies. The base height distribution for subsidence inversions was quite similar for both 0000 GMT and 1200 GMT cases; however, surface-based inversions were about twice as common at 1200 GMT than at 0000 GMT.

L. Glasgow NWS Surface-Based Inversion Depth Characteristics

Figures 20A and 20B give frequency distributions for surface-based inversion depths for 0000 GMT and 1200 GMT, respectively. Histogram bars for the interval "0 - 0" indicate percentages of the time when no surface-based inversions were observed.

Surface-based inversions occur frequently in Glasgow; a surface-based inversion layer was present in 26 percent of the 0000 GMT observations and in 82 percent of the 1200 GMT observations. This difference is explained by the favorable conditions which exist at 1200 GMT for the formation of nocturnal radiation inversions; at 0000 GMT, solar heating is occurring during spring, summer, and fall. At 0000 GMT, about half the surface-based inversions that occur have depths between 0 and 10 mb, while other inversion depths between 0 and 80 mb occur with nearly equal frequencies. Inversions with depths greater than 80 mb are rare. At 1200 GMT, inversion depths between 0 and 50 mb (500 M) are most common; depths between 30 (300 M) and 40 mb (400 M) are found in

Figure 19A.--Height of Lowest Inversion Layer Above Ground 0000 GMT

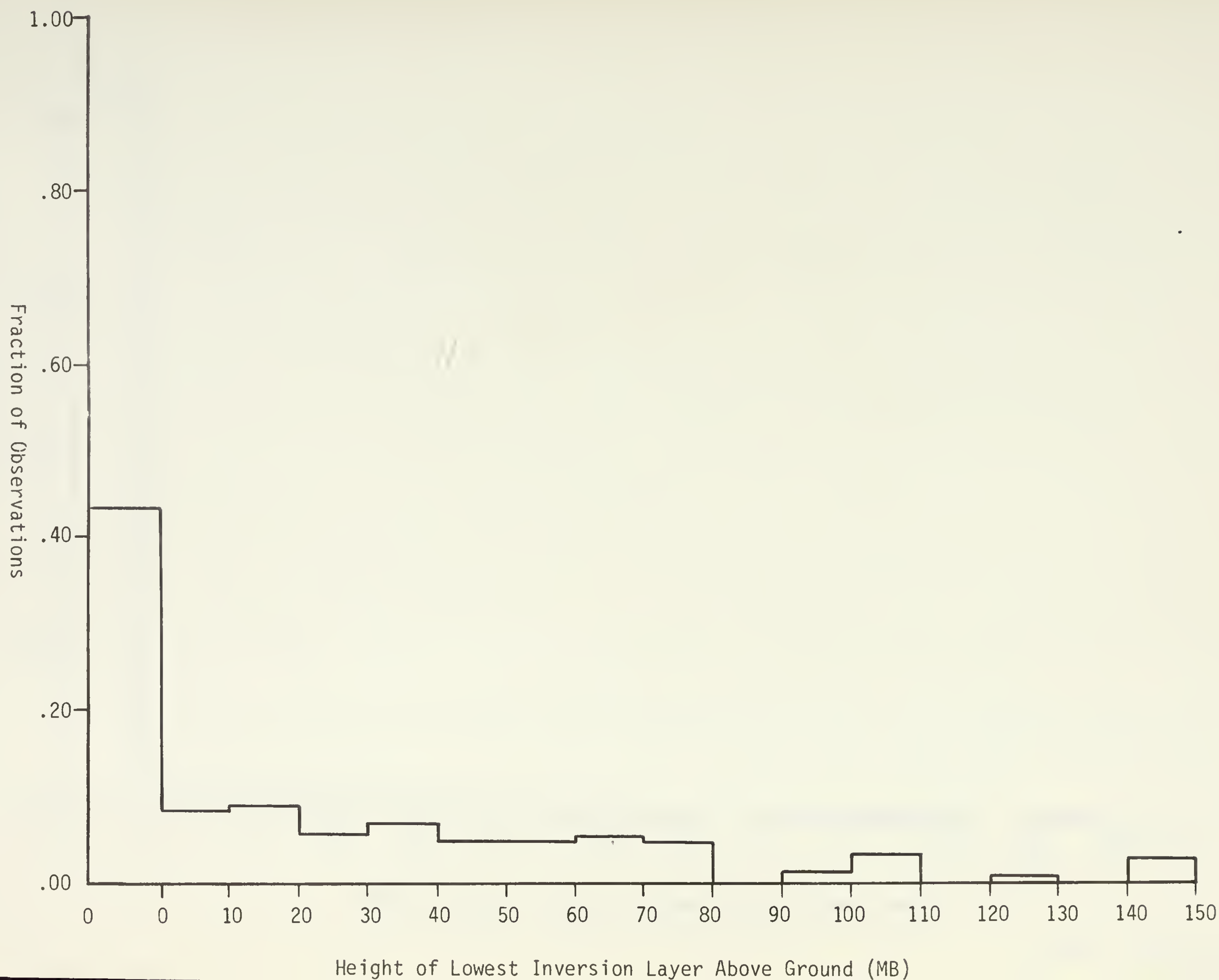


Figure 19B.--Height of Lowest Inversion Layer Above Ground 1200 GMT

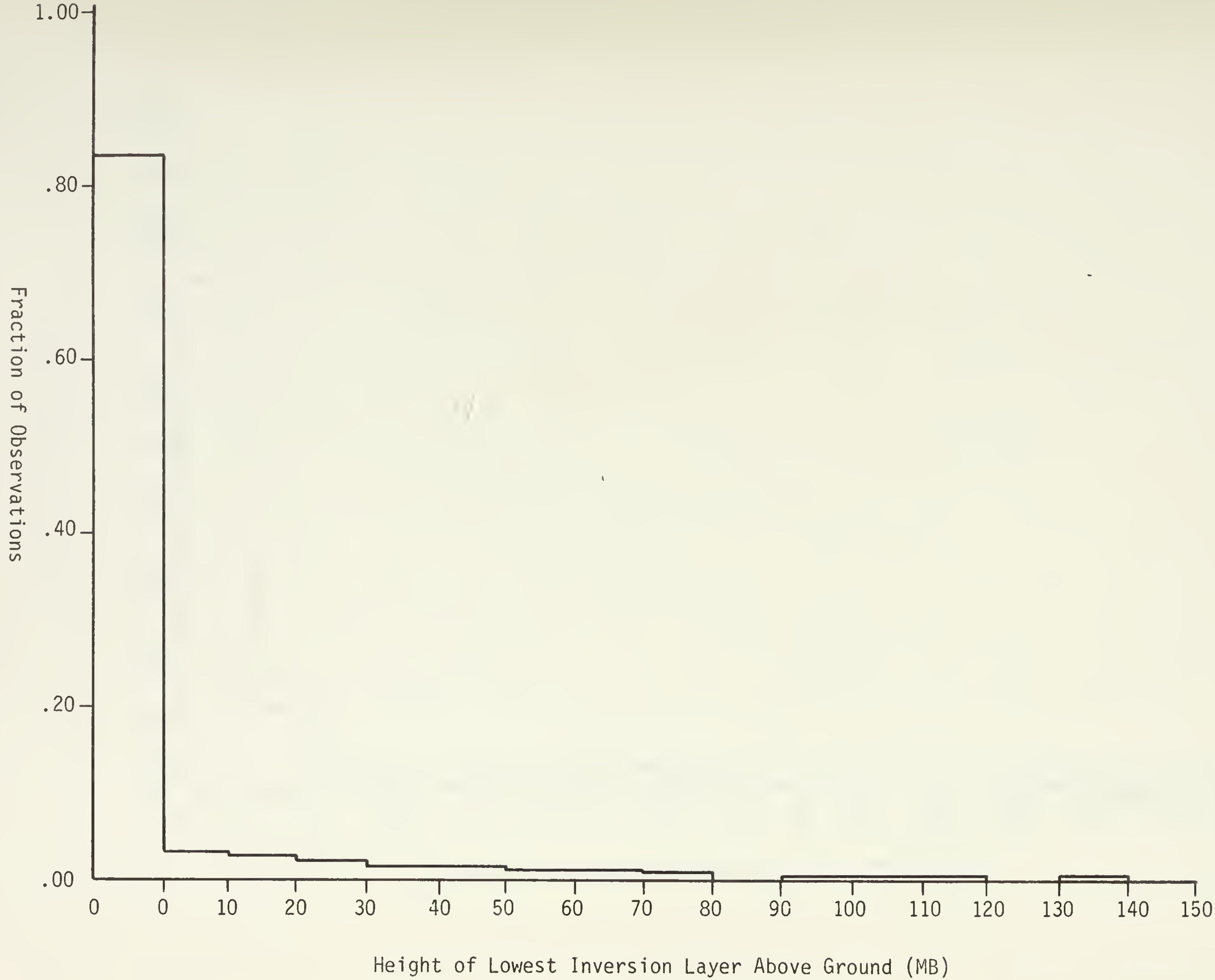


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Figure 20A.--Depth of Surface-Based Inversion 0000 GMT

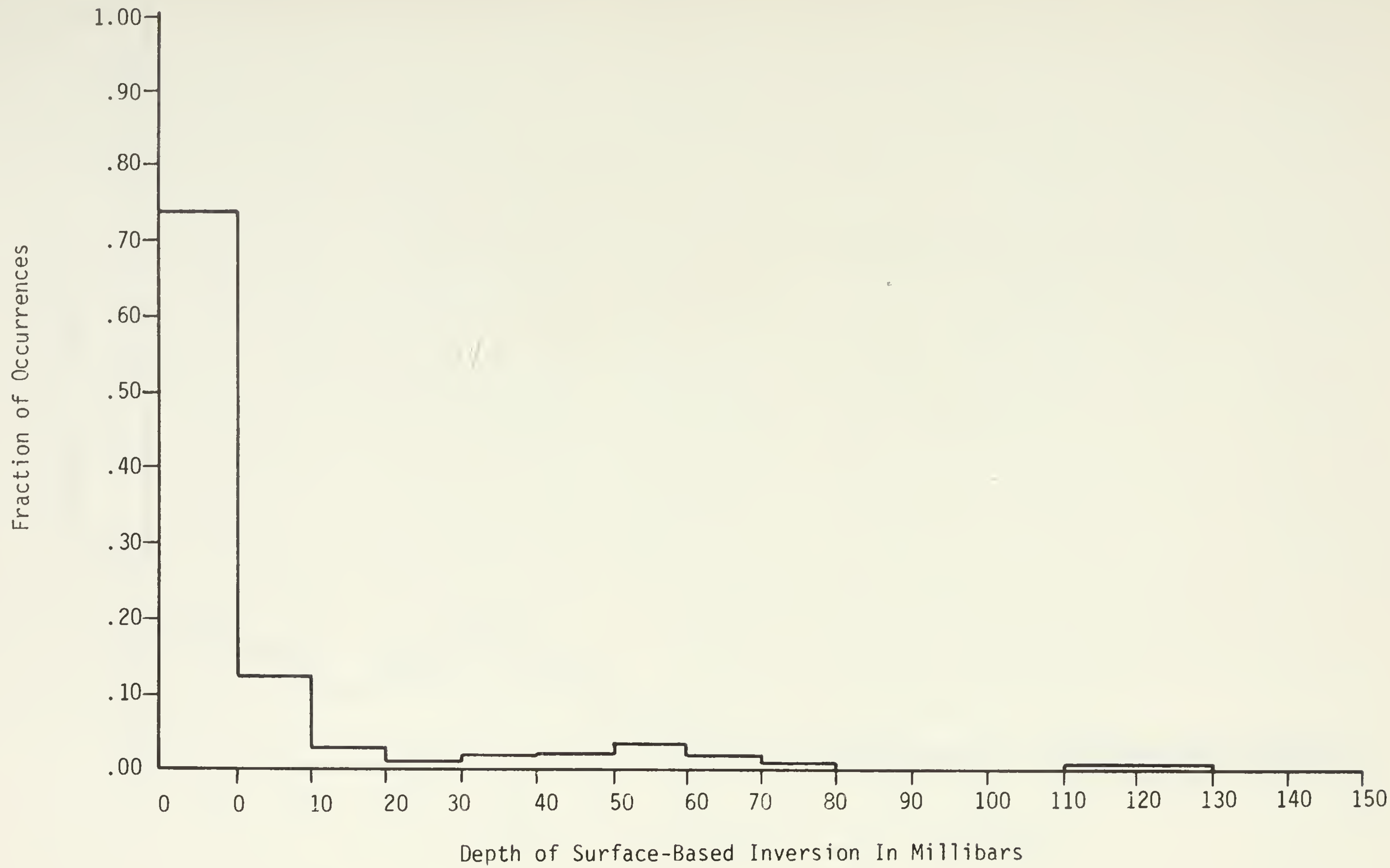

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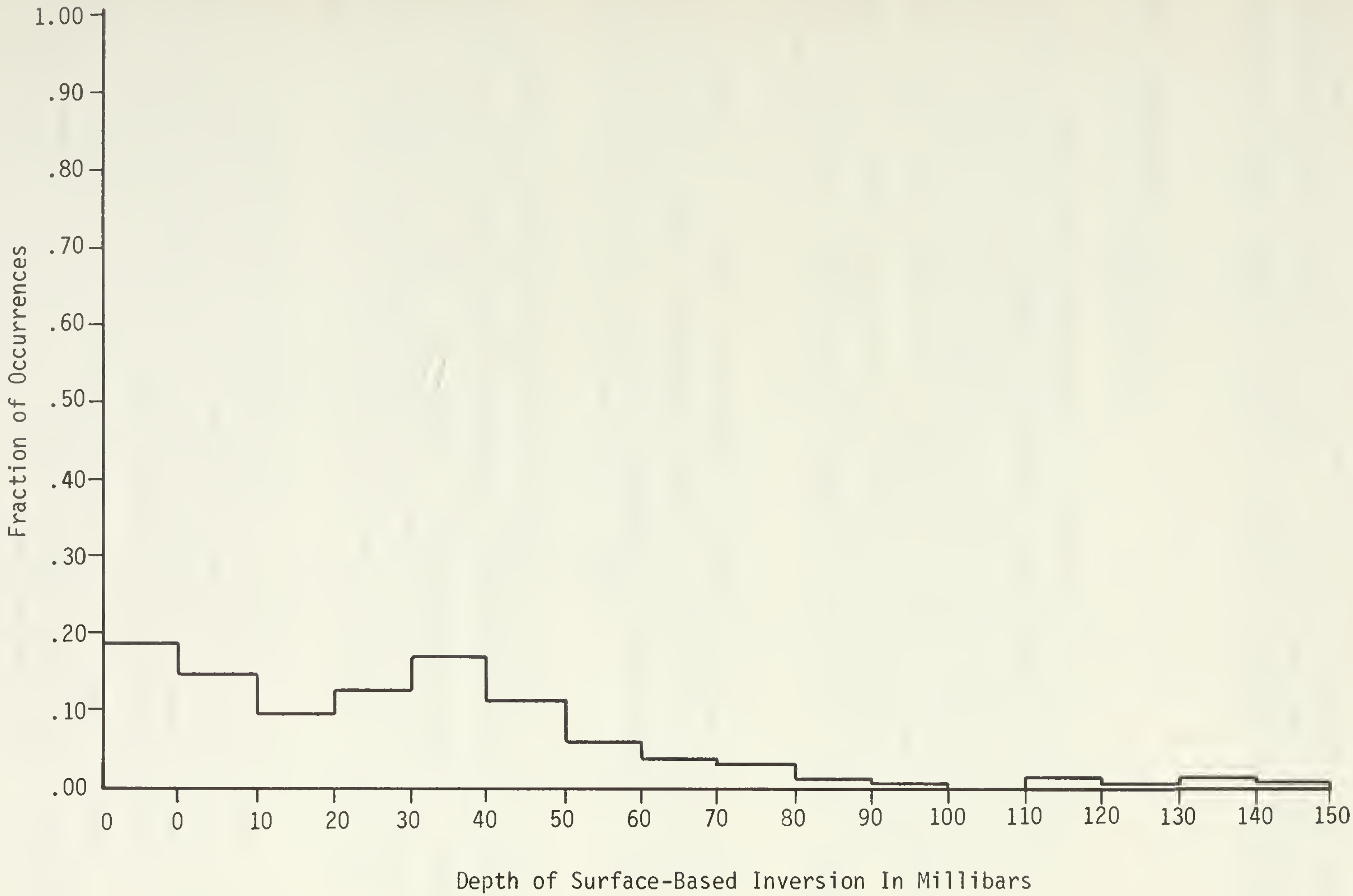
Figure 20B.--Depth of Surface-Based Inversion 1200 GMT



10-5-78 21-000-076-A

about 17 percent of the observations when inversions are present. Inversions with depths greater than 80 mb are rare. It can be seen that surface-based inversions are more common and tend to be deeper at 1200 GMT than at 0000 GMT.

IV. GLASGOW TEMPERATURE CHARACTERISTICS

The climate of the Glasgow area is characterized by large seasonal temperature variations, as well as high day-to-day temperature variability. Table 1 indicates monthly temperature averages ranging from -18.7°C in January to 20.7°C in July. Diurnal ranges are usually moderate; average diurnal ranges varied from 5.6°C in February to 10.8°C in June, although a range of 15°C or more was observed at least once in most months. High monthly variations in temperature were common; in March, for example, temperatures ranged from -26.5°C to 17.8°C.

A comparison of average temperatures at GAFB and Glasgow NWS reveals great similarity; monthly temperature averages at the two locations never differed by more than 1.4°C. Overall temperature averages during the study period were 2.6°C at Glasgow NWS and 2.5°C at GAFB.

A comparison of Glasgow NWS monthly temperature averages during this study period with normal monthly temperature averages shows that the winter of 1977-1978 was much colder than normal. Temperatures averaged 6.2°C below normal in January, 4.9°C below normal in December, and 4.4°C below normal in February. Slightly above normal temperatures were recorded in April, May, and June.

A very important wintertime consideration is the wind chill factor. The wind chill factor is the still air temperature that would have the same cooling effect on exposed human flesh as a given combination of temperature and wind speed. The wind chill effect is more pronounced at lower temperatures; in October, for example, the average temperature was 8.2°C, and the average wind chill temperature was 2°C. In January, however, the average temperature was -18.7°C, while the average wind chill temperature was -32°C. Wind chill

Table 1.--GLASGOW TEMPERATURE DATA (ALL VALUES ARE IN °C)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG
AVERAGE TEMPERATURE	8.2	-3.9	-13.1	-18.7	-13.6	-4.1	5.2	12.0	16.4	20.7	18.9
AVERAGE MAXIMUM TEMPERATURE	12.5	0.3	9.8	-15.3	-10.8	-0.7	9.5	16.7	21.8	25.6	24.8
AVERAGE MINIMUM TEMPERATURE	3.9	-8.2	-16.4	-22.1	-16.4	-7.6	0.8	7.2	11.0	15.7	13.0
GREATEST DIURNAL RANGE	15.0	15.0	22.8	20.2	10.8	13.3	16.7	18.8	14.9	16.1	16.5
HIGHEST TEMPERATURE	16.2	14.4	5.5	-3.5	2.4	17.8	18.0	31.0	28.1	33.1	33.4
LOWEST TEMPERATURE	-0.2	-20.0	-36.6	-28.4	-25.5	-26.5	-4.4	3.2	4.2	10.5	4.0
AVERAGE GLASGOW NWS TEMPERATURE	7.8	-4.2	-13.2	-18.9	-13.7	-4.2	6.6	12.7	17.1	19.5	18.8
NORMAL GLASGOW NWS TEMPERATURE	8.0	-1.7	-8.3	-12.7	-9.3	-3.8	6.0	12.3	16.7	21.4	20.6
AVERAGE WIND CHILL FACTOR	2	-13	-26	-32	-29	-12	-5	--	--	--	--

temperatures averaged about 20°C colder than ambient temperatures in December, January, and February and about 10°C colder than ambient in other months. These figures indicate that during winter months, the wind chill effect is a very important consideration for human comfort in the Glasgow area.

V. SOLAR ENERGY CHARACTERISTICS

Another possible re-use for GAFB is a solar energy production center. To assess the feasibility of this alternative, it is necessary to examine the seasonal and diurnal variations in incoming solar radiation. Solar data was collected with a normal incidence pyrheliometer, as well as a precision spectral pyranometer. Data collected by these instruments then was reduced by computer to yield monthly hourly averages of direct beam normal incidence and diffuse solar radiation; the results are presented in Tables 2A and 2B.

From Table 2A, it is evident that direct beam normal incidence solar radiation shows a strong seasonal dependence. Direct beam normal incidence solar radiation is highest during the summer months and lowest in the winter. From October through April, the highest values generally occur near the time of solar noon. During May, June, and August, however, the highest values usually occur one or two hours before noon. This may occur because mornings during late spring and summer are generally clear, while an increase in cloudiness due to cumulus cloud buildups often occurs around mid-day during late spring and summer. The highest average direct beam normal incidence solar radiation, .87 Ly/min., was observed in August at 1000 MST. In April, however, the highest hourly average was only .37 Ly/min., observed at 1200 MST.

Table 2B shows that diffuse radiation values are lower than direct beam normal incidence radiation values during all months except February and April--this difference is most pronounced during the summer. Diffuse radiation values are lowest in fall and early winter and highest in spring. Diffuse radiation values are usually highest around mid-day. Highest mid-day averages ranged from .19 Ly/min in November to .53 Ly/min in June (the value of .50 Ly/min observed in March represents only half a month of data).

Table 2A.--MONTHLY HOURLY AVERAGES OF DIRECT BEAM NORMAL INCIDENCE SOLAR RADIATION
(ALL VALUES ARE IN LANGLEYS/MIN)

HOUR	OCT*	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
0500	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.03	0.11	0.06	0.01
0600	0.00	0.00	0.00	0.00	0.00	NA	0.02	0.24	0.33	0.40	0.27
0700	0.00	0.00	0.00	0.00	0.00	NA	0.09	0.38	0.41	0.59	0.53
0800	0.08	0.09	0.00	0.00	0.05	NA	0.18	0.52	0.54	0.69	0.78
0900	0.15	0.37	0.11	0.13	0.14	NA	0.26	0.60	0.65	0.67	0.84
1000	0.21	0.46	0.24	0.25	0.15	NA	0.33	0.69	0.68	0.61	0.87
1100	0.32	0.57	0.34	0.32	0.21	NA	0.34	0.68	0.67	0.62	0.86
1200	0.52	0.65	0.38	0.35	0.26	NA	0.37	0.63	0.63	0.66	0.84
1300	0.64	0.64	0.33	0.38	0.29	NA	0.35	0.55	0.61	0.72	0.79
1400	0.56	0.62	0.30	0.34	0.40	NA	0.33	0.60	0.63	0.81	0.76
1500	0.50	0.52	0.27	0.31	0.38	NA	0.26	0.60	0.50	0.80	0.77
1600	0.46	0.32	0.17	0.24	0.34	NA	0.14	0.50	0.39	0.76	0.72
1700	0.18	0.04	0.00	0.04	0.21	NA	0.06	0.38	0.42	0.78	0.77
1800	0.00	0.00	0.00	0.00	0.04	NA	0.01	0.24	0.41	0.65	0.60
1900	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.11	0.23	0.50	0.33
2000	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.01	0.07	0.12	0.04
2100	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00
2200	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00

NA = Not available due to loss of data.

* = Averages are based on partial data base.

Table 2B.--MONTHLY HOURLY AVERAGES OF DIFFUSE SOLAR RADIATION
(ALL VALUES ARE IN LANGLEYS/MIN)

HOUR	OCT*	NOV	DEC	JAN	FEB	MAR*	APR	MAY	JUN	JUL	AUG
0500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.01
0600	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.11	0.07	0.04
0700	0.01	0.00	0.00	0.00	0.00	0.01	0.10	0.09	0.20	0.12	0.09
0800	0.06	0.03	0.00	0.00	0.04	0.04	0.20	0.15	0.29	0.15	0.15
0900	0.17	0.10	0.06	0.05	0.16	0.23	0.29	0.21	0.35	0.23	0.21
1000	0.26	0.15	0.13	0.14	0.29	0.07	0.35	0.28	0.39	0.31	0.26
1100	0.31	0.18	0.19	0.21	0.39	0.23	0.39	0.32	0.47	0.34	0.32
1200	0.28	0.18	0.21	0.27	0.48	0.54	0.43	0.39	0.53	0.36	0.34
1300	0.23	0.19	0.23	0.30	0.46	0.57	0.39	0.41	0.50	0.35	0.35
1400	0.16	0.16	0.19	0.26	0.40	0.58	0.39	0.42	0.38	0.26	0.32
1500	0.13	0.11	0.12	0.16	0.31	0.49	0.37	0.34	0.39	0.28	0.28
1600	0.09	0.06	0.04	0.07	0.20	0.33	0.30	0.27	0.37	0.24	0.24
1700	0.03	0.01	0.00	0.01	0.08	0.27	0.25	0.23	0.27	0.21	0.17
1800	0.00	0.00	0.00	0.00	0.01	0.10	0.14	0.16	0.18	0.12	0.10
1900	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.12	0.10	0.05
2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.04	0.01
2100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* = Averages are based on partial data base.

VI. GLASGOW PRECIPITATION CHARACTERISTICS

Table 3 shows precipitation data from GAFB and Glasgow NWS. GAFB precipitation data is inaccurate from November through March; precipitation during this period usually falls as snow, and the water content of frozen precipitation was not measured accurately by the tipping bucket rain gauge at GAFB. During other months when precipitation fell mainly as rain, 255.77 mm of precipitation fell at Glasgow NWS, while 244.85 mm fell at GAFB. These values are very similar for two stations located 20 miles apart. High interstation variability was observed during individual months however; in June, for example, 99.06 mm of precipitation fell at GAFB, while Glasgow NWS recorded only 69.09 mm. Conversely, in July GAFB had 28.19 mm of precipitation, while Glasgow NWS had 66.80 mm. These differences appear to balance out over long periods of time.

The heaviest precipitation, as well as the greatest precipitation intensities, occurred in the spring. A one-day total of 34.54 mm was observed in May; one-hour and three-hour totals of 10.41 mm and 18.80 mm were observed in June.

A comparison of monthly Glasgow NWS precipitation totals with Glasgow NWS mean monthly totals show that this study period was slightly wetter than average; 305.05 mm of precipitation fell, compared to a normal of 254.50 mm. May and July were especially wet months. This implies that GAFB precipitation may have been slightly greater than normal.

Humidity at Glasgow varies considerably during the year. During the winter months, humidity averages nearly 70 percent; and mornings are slightly more humid than afternoons. During the remainder of the year, humidity averages nearly 75 percent during morning hours and nearly 65 percent during evening hours. Afternoon hours show considerable seasonal variation however; humidities of 30 to 40 percent are common in August, the least humid month. Afternoon humidities are commonly 45 to 55 percent in the spring and 40 to 50 percent in the fall. Of course, humidity during any time of year can vary considerably depending on the types of weather patterns that exist over the area.

Table 3.--GLASGOW PRECIPITATION DATA (ALL VALUES ARE IN MM)

	OCT	NOV*	DEC*	JAN*	FEB*	MAR*	APR	MAY	JUN	JUL	AUG
TOTAL PRECIPITATION	8.13	1.52	4.83	1.02	7.11	0.00	8.13	98.04	99.06	28.19	3.30
MAXIMUM 1-HOUR TOTAL	4.32	0.51	0.76	0.76	4.57	0.00	1.27	7.11	10.41	9.14	1.02
MAXIMUM 3-HOUR TOTAL	7.37	0.76	1.02	0.76	4.57	0.00	2.29	14.48	18.80	14.99	1.27
MAXIMUM DAILY TOTAL	8.13	0.76	2.03	0.76	4.57	0.00	3.81	34.54	27.43	15.49	1.27
TOTAL GLASGOW NWS PRECIPITATION	10.16	6.10	21.84	4.83	10.16	6.35	12.95	92.71	69.09	66.80	4.06
MEAN GLASGOW NWS PRECIPITATION	14.22	9.91	7.87	9.91	8.13	9.40	18.03	33.27	69.09	36.32	38.35
TOTAL EVAPORATION								137.16	175.77		

* Glasgow AFB precipitation totals are incorrect during these months because the tipping bucket rain gauge does not correctly measure the water content of frozen precipitation.

VII. BAROMETRIC PRESSURE CHARACTERISTICS

Table 4 shows GAFB barometric pressure data. The lowest pressure average, 910.6 mb, occurred in April; this probably was associated with the frequent passages of low-pressure systems during that time of year. The highest pressure average, 918.0 mb, occurred in January; this probably was due to the prolonged prescence of polar anticyclones over the area.

The fraction of all pressure observations within each 10 mb pressure interval also is given. During December, barometric pressures within all intervals were observed, while in some months, pressures within only three of the intervals were observed. This indicates fairly consistent barometric pressures in some months and highly variable pressures in other months (e.g., December). The highest pressures tend to occur in winter months, while the lowest pressures occurred in spring. The pressure at GAFB is normally 20 mb lower than the pressure at Glasgow NWS due to an elevation difference. GAFB is at an elevation of 827 meters, while Glasgow NWS is at an elevation of 696 meters.

VIII. AIR QUALITY OF THE GLASGOW AIR FORCE BASE

In association with the meteorological monitoring at GAFB, MERDI collected air quality data from January through August 1978. This information delineates the current air quality of the region and provides a base for projecting the resultant impacts of future developments in the area on air quality.

MERDI's air quality program consisted of collecting 24-hour high-volume air samples every third day and setting out a dustfall jar and static samples (sulfation plate, nitration plate, and fluoridation plate) for a month at a time. The high-volume samples and dustfall jars were analyzed for total particulates and 28 trace elements (see Table 5). The monthly air quality printouts are shown in Tables 6 through 13.

Table 4.--GLASGOW AFB BAROMETRIC PRESSURE DATA

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
AVERAGE BAROMETRIC PRESSURE	910.7	915.7	913.2	918.0	915.9	913.3	910.6	911.4	913.4	914.0	913.9
STANDARD DEVIATION	6.3	3.4	7.6	3.7	2.2	1.8	2.3	1.0	3.7	7.6	2.3
PERCENT OF OBSERVATIONS BETWEEN:											
890-900 MB	0.0	1.8	4.4	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0
900-910 MB	42.2	15.9	40.1	13.9	15.3	33.6	37.8	39.1	24.5	21.8	26.5
910-920 MB	57.8	56.1	29.3	47.7	64.6	52.2	54.7	52.7	67.7	60.8	57.9
920-930 MB	0.0	26.3	21.6	34.5	17.5	14.1	3.1	8.2	7.9	17.4	15.6
930-940 MB	0.0	0.0	4.6	3.8	2.6	0.0	0.0	0.0	0.0	0.0	0.0

Table 5.--TRACE ELEMENTS ANALYZED IN HIGH-VOLUME AND DUSTFALL SAMPLES

Aluminum (Al)	Mercury (Hg)
Arsenic (As)	Potassium (K)
Boron (B)	Magnesium (Mg)
Beryllium (Be)	Manganese (Mn)
Benzene solubles (Ben Sol)	Molybdenum (Mo)
Bismuth (Bi)	Sodium (Na)
Calcium (Ca)	Nickel (Ni)
Cadmium (Cd)	Lead (Pb)
Chlorine (Cl)	Antimony (Sb)
Cobalt (Co)	Selenium (Se)
Chromium (Cr)	Tin (Sn)
Copper (Cu)	Sulfate (SOu)
Fluorine (F)	Vanadium (V)
Iron (Fe)	Zinc (Zn)

Table 6A

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JANUARY, 1979

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	2	5	8	11	14	17	20	23	26	29
MONTANA	TSP	12	13	6	6	12	19	13	9	3	1
	AL	****	3	****	6	****	6	****	3	****	3
SUSPENDED SULFATE	AS	****	1	****	1	****	3	****	0	****	0
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	0	****	0	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	1	****	1	****	5	****	2	****	1
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	0	****	0	****	0	****	0	****	0
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	0	****	0	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	****	4	****	4	****	5	****	3	****	4
	CU	****	13	****	111	****	44	****	266	****	84
BERYLLIUM	F	****	1	****	1	****	2	****	1	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	****	25	****	25	****	158	****	11	****	14
	HG	0	****	1	****	4	****	1	****	0	****
	K	6	****	3	****	35	****	17	****	3	****
FEDERAL	MG	16	****	21	****	-17	****	47	****	13	****
	MN	1	****	1	****	-3	****	1	****	0	****
TOT SUSPENDED PARTICULATE	MO	0	****	0	****	0	****	-58	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	1	****	1	****	0	****	1	****	0	****
260 UG/M3 AIR, ONCE/YEAR	PB	3	****	3	****	1	****	5	****	2	****
SECONDARY	SB	1	****	0	****	1	****	1	****	0	****
60 UG/M3 AIR, ANN GEO MEAN	SE	1	****	0	****	0	****	1	****	1	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	487	****	458	****	1066	****	852	****	720	****
LEAD	V	0	****	0	****	0	****	0	****	0	****
PENDING	ZN	1	****	1	****	0	****	1	****	0	****
BERYLLIUM						DAILY WIND ROSE (% OF TIME)					
PENDING	N	1	0	5	0	25	56	8	0	0	0
	NE	0	6	17	24	5	8	8	0	3	0
	E	0	100	60	27	26	13	9	0	50	0
	SE	0	0	16	46	13	0	0	0	48	0
	S	9	0	0	3	13	0	0	0	0	0
	SW	16	0	0	1	0	0	1	13	0	0
	W	44	0	0	0	0	0	62	50	0	0
	NW	39	0	2	0	18	23	12	37	0	0
						WIND SPEEDS (% OF TIME)					
	CALM	0	0	0	1	6	0	1	0	0	0
	<4 M/S	63	5	28	73	94	42	92	13	71	0
	>=4 M/S	37	95	72	26	0	58	7	87	29	0
	TEMP (C)	-15	-16	-23	-19	-13	-19	-21	-8	-20	-18

Table 6B

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JANUARY, 1978

10/17/78
AIRQUAL

HI-VOL MONTHLY SUMMATION / MONTHLY DUSTFALL CONCENTRATIONS

	<=MEAN<=	RANGE	Dustfall
SOLUBLE PARTICULATES**			1.8
INSOLUBLE PARTICULATES			4.1
TOTAL PARTICULATES			5.9
TSP*	7	1 TO 19	
AL	4	3 TO 6	1
AS	1	0 TO 3	1
B	****	**** TO ****	****
BE	0	0 TO 0	0
BEN SOL	****	**** TO ****	****
BI	2	1 TO 5	0
CA	****	**** TO ****	****
CD	0	0 TO 0	0
CL	****	**** TO ****	****
CO	0	0 TO 0	0
CR	4	3 TO 5	1
CU	104	13 TO 265	2
F	1	1 TO 2	****
FE	47	11 TO 158	90
HG	1	0 TO 4	1
K	13	3 TO 35	3
MG	23	13 TO 47	2
MN	1	-3 TO 1	7
MO	0 12	-58 TO 0	0
NA	****	**** TO ****	****
NI	0	0 TO 1	0
PB	3	1 TO 5	1
SB	1	0 TO 1	1
SE	1	0 TO 1	0
SN	****	**** TO ****	****
SO4	717	458 TO 1066	****
V	0	0 TO 0	0
ZN	1	0 TO 1	0

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

* TSP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
ISP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.00 MG SO3/100 CM2/DY

NITRATION RATE
0.00 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.02 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.04 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	3	4
NNE	1	1
NE	3	0
ENE	6	2
E	6	9
ESE	4	8
SE	2	4
SSE	1	0
S	0	0
SSW	1	0
SW	3	0
WSW	3	1
W	5	4
WNW	3	6
NW	2	6
NNW	2	7

CALM 1

AVERAGE TEMPERATURE (C)	-18.3
MAXIMUM TEMPERATURE (C)	-3.5
MINIMUM TEMPERATURE (C)	-28.4
BAROMETRIC PRESSURE (MB)	918.0
TOTAL PRECIPITATION (MM)	1.02
TOTAL EVAPORATION (MM)	******

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 41N40E54CCDB
ELEVATION: 827 METERS

FEBRUARY, 1978

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	1	4	7	10	13	16	19	22	25	28
MONTANA	TSP	6	16	32	5	6	17	13	12	3	10
	AL	5	10	****	2	****	12	****	7	****	13
SUSPENDED SULFATE	AS	0	1	****	1	****	0	****	1	****	1
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	0	0	****	0	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	2	1	****	1	****	1	****	1	****	0
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	0	0	****	0	****	0	****	0	****	0
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	0	0	****	0	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	4	5	****	5	****	3	****	2	****	4
	CU	252	59	****	8	****	89	****	123	****	65
BERYLLIUM	F	1	1	****	1	****	3	****	2	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	18	212	****	189	****	95	****	30	****	165
	HG	****	****	1	****	2	****	0	****	0	****
	K	****	****	5	****	250	****	85	****	126	****
FEDERAL	MG	****	****	0	****	187	****	33	****	68	****
	MN	****	****	0	****	34	****	2	****	3	****
TOT SUSPENDED PARTICULATE	MO	****	****	0	****	0	****	0	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	****	****	6	****	1	****	0	****	0	****
260 UG/M3 AIR, ONCE/YEAR	PB	****	****	7	****	3	****	9	****	8	****
SECONDARY	SB	****	****	1	****	0	****	0	****	0	****
60 UG/M3 AIR, ANN GEO MEAN	SE	****	****	0	****	0	****	1	****	0	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	****	****	1085	****	****	****	1206	****	551	****
LEAD	V	****	****	3	****	2	****	****	****	****	****
PENDING	ZN	****	****	0	****	2	****	1	****	1	****
BERYLLIUM	DAILY WIND ROSE (% OF TIME)										
PENDING	N	0	22	0	0	26	1	24	1	14	0
	NE	0	1	0	13	64	0	0	0	17	0
	E	0	54	65	85	10	0	0	0	8	64
	SE	0	18	35	1	0	0	0	3	42	36
	S	0	1	0	0	0	0	0	8	1	0
	SW	0	0	0	0	0	16	0	13	1	0
	W	0	0	0	0	0	60	8	21	2	0
	NW	0	2	0	0	0	23	68	54	15	0
	WIND SPEEDS (% OF TIME)										
	CALM	0	2	0	0	0	3	0	1	0	0
	<4 M/S	0	41	0	0	98	94	14	33	25	18
	>=4 M/S	0	57	100	100	2	3	86	66	75	82
	TEMP (C)	-24	-19	-14	-12	-13	-19	-7	-1	-12	-17

Table 7B

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 41N40E54CCDB
ELEVATION: 827 METERS

FEBRUARY, 1978

HI-VOL MONTHLY SUMMATION / MONTHLY DUSTFALL CONCENTRATIONS

	SOLUBLE PARTICULATES**	2.3
	INSOLUBLE PARTICULATES	1.9
	TOTAL PARTICULATES	4.1

	<=MEAN<=	RANGE	DUSTFALL
TSP*	10	5 TO 52	
AL	8	2 TO 13	1
AS	1	0 TO 1	0
B	****	**** TO ****	****
BE	0	0 TO 0	0
BEN SOL	****	**** TO ****	****
BI	1	0 TO 2	0
CA	****	**** TO ****	****
CD	0	0 TO 0	0
CL	****	**** TO ****	****
CO	0	0 TO 0	0
CR	4	2 TO 5	1
CU	99	8 TO 252	4
F	1	1 TO 3	****
FE	118	18 TO 212	44
HG	1	0 TO 2	1
K	116	3 TO 250	59
MG	72	0 TO 187	27
MN	10	0 TO 34	3
MO	0	0 TO 0	0
NA	****	**** TO ****	****
NI	2	0 TO 5	1
PB	7	3 TO 9	0
SB	1	0 TO 1	0
SE	0	0 TO 1	0
SN	****	**** TO ****	****
SO4	947	551 TO 1206	****
V	2	2 TO 3	0
ZN	1	0 TO 2	0.

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

* TSP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
TSP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTLEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.00 MG SO3/100 CM2/DY

NITRATION RATE
0.11 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.02 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.08 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	5	1
NNE	3	0
NE	3	1
ENE	2	5
E	2	7
ESE	2	24
SE	1	2
SSE	1	0
S	1	0
SSW	1	0
SW	3	1
WSW	3	1
W	4	1
WNW	3	6
NW	2	8
NNW	2	4
CALM	1	

AVERAGE TEMPERATURE (C)	-13.5
MAXIMUM TEMPERATURE (C)	2.4
MINIMUM TEMPERATURE (C)	-25.5
BAROMETRIC PRESSURE (MB)	915.9
TOTAL PRECIPITATION (MM)	7.11
TOTAL EVAPORATION (MM)	******

Table 8A

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

MARCH, 1978

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	3	6	9	12	15	18	21	24	27	30
MONTANA	TSP	11	14	5	6	5	5	4	4	8	9
	AL	****	13	****	10	****	58	****	87	****	151
SUSPENDED SULFATE	AS	****	1	****	0	****	0	****	0	****	0
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	0	****	0	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	1	****	1	****	1	****	1	****	0
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	0	****	0	****	0	****	0	****	0
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	0	****	0	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	****	4	****	3	****	2	****	3	****	2
	CU	****	109	****	20	****	230	****	113	****	140
BERYLLIUM	F	****	4	****	1	****	0	****	0	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	****	255	****	115	****	64	****	102	****	157
	HG	1	****	0	****	2	****	6	****	5	****
	K	94	****	51	****	64	****	49	****	55	****
FEDERAL	MG	70	****	16	****	27	****	38	****	46	****
	MN	12	****	1	****	1	****	2	****	3	****
TOT SUSPENDED PARTICULATE	MO	0	****	0	****	-58	****	0	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	0	****	0	****	0	****	2	****	3	****
260 UG/M3 AIR, ONCE/YEAR	PB	7	****	9	****	7	****	12	****	12	****
SECONDARY	SB	0	****	0	****	0	****	0	****	0	****
60 UG/M3 AIR, ANN GEO MEAN	SE	0	****	0	****	0	****	0	****	0	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	463	****	273	****	662	****	326	****	414	****
LEAD	V	****	****	****	****	****	****	****	****	****	****
PENDING	ZN	0	****	0	****	0	****	2	****	2	****
BERYLLIUM		DAILY WIND ROSE (% OF TIME)									
PENDING	N	30	4	6	6	10	13	22	0	41	11
	NE	2	42	17	94	0	0	0	0	42	13
	E	10	17	1	1	0	0	0	0	7	14
	SE	26	31	7	0	0	0	0	54	0	12
	S	6	3	17	0	0	0	2	28	0	11
	SW	18	3	17	0	0	0	13	15	0	7
	W	1	0	6	0	56	53	24	3	0	25
	NW	6	0	27	6	33	33	40	0	10	8
		WIND SPEEDS (% OF TIME)									
	CALM	2	0	1	0	0	0	0	0	1	1
	<4 M/S	94	94	89	8	8	1	58	40	78	44
	>=4 M/S	4	6	10	92	92	99	42	60	21	54
	TEMP (C)	-24	-14	1	-3	-7	-1	1	0	4	11

Table 8B

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

MARCH, 1978

10/17/78
AIRQUAL
PAGE 2 OF 2

HI-VOL MONTHLY SUMMATION / MONTHLY DUSTFALL CONCENTRATIONS

	<=MEAN<=	RANGE	Dustfall
TSP*	5	0 TO 13	
AL	64	10 TO 151	3
AS	0	0 TO 1	0
B	****	**** TO ****	****
BE	0	0 TO 0	0
BEN SOL	****	**** TO ****	****
BI	1	0 TO 1	0
CA	****	**** TO ****	****
CD	0	0 TO 0	0
CL	****	**** TO ****	****
CO	0	0 TO 0	0
CR	3	2 TO 4	0
CU	122	20 TO 230	1
F	1	0 TO 4	****
FE	139	64 TO 255	3
HG	3	0 TO 6	0
K	63	49 TO 94	46
MG	40	16 TO 70	16
MN	4	1 TO 12	2
MO	0 12	-58 TO 0	0
NA	****	**** TO ****	****
NI	1	0 TO 3	1
PB	9	7 TO 12	0
SB	0	0 TO 0	0
SE	0	0 TO 0	0
SN	****	**** TO ****	****
SO4	428	273 TO 662	****
V	****	**** TO ****	****
ZN	1	0 TO 2	0

MONTHLY DUSTFALL CONCENTRATIONS

SOLUBLE PARTICULATES**	1.8
INSOLUBLE PARTICULATES	0.4
TOTAL PARTICULATES	2.4

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

* TSP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
ISP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.01 MG SO3/100 CM2/DY

NITRATION RATE
0.08 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.02 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.00 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	5	4
NNE	4	1
NE	4	3
ENE	3	2
E	3	2
ESE	4	5
SE	4	5
SSE	2	1
S	2	0
SSW	2	0
SW	5	2
WSW	5	2
W	3	4
WNW	2	7
NW	3	4
NNW	2	3
CALM	1	

AVERAGE TEMPERATURE (C)	-4.1
MAXIMUM TEMPERATURE (C)	17.8
MINIMUM TEMPERATURE (C)	-26.5
BAROMETRIC PRESSURE (MB)	913.3
TOTAL PRECIPITATION (MM)	0.00
TOTAL EVAPORATION (MM)	******

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

APRIL, 1978

10/17/78
AIRQUAL

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	2	5	8	11	14	17	20	23	26	29
MONTANA	TSP	5	7	14	****	****	10	6	0	39	32
	AL	****	157	****	****	****	122	****	56	****	491
SUSPENDED SULFATE	AS	****	0	****	****	****	1	****	0	****	3
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	0	****	****	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	0	****	****	****	1	****	1	****	1
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	0	****	****	****	0	****	0	****	1
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	0	****	****	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	****	3	****	****	****	4	****	3	****	5
	CU	****	52	****	****	****	61	****	164	****	75
BERYLLIUM	F	****	0	****	****	****	0	****	0	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	****	145	****	****	****	140	****	53	****	381
	HG	5	****	7	****	****	****	****	****	3	****
	K	65	****	111	****	****	****	****	****	244	****
FEDERAL	MG	33	****	76	****	****	****	****	****	169	****
	MN	3	****	5	****	****	****	****	****	14	****
TOT SUSPENDED PARTICULATE	MO	0	****	0	****	****	****	****	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	1	****	5	****	****	****	****	****	4	****
260 UG/M3 AIR, ONCE/YEAR	PB	7	****	11	****	****	****	****	****	10	****
SECONDARY	SB	0	****	1	****	****	****	****	****	2	****
60 UG/M3 AIR, ANN GEO MEAN	SE	0	****	2	****	****	****	****	****	1	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	724	****	910	****	****	****	****	****	480	****
LEAD	V	****	****	****	****	****	****	****	****	2	****
PENDING	ZN	2	****	2	****	****	****	****	****	22	****
BERYLLIUM	DAILY WIND ROSE (% OF TIME)										
PENDING	N	21	0	0	0	0	35	0	0	0	0
	NE	3	0	0	0	1	5	0	0	0	1
	E	1	33	6	1	57	42	21	0	87	45
	SE	45	3	55	23	43	3	79	0	13	42
	S	6	1	13	19	0	0	0	0	0	9
	SW	4	1	8	0	0	0	0	0	0	0
	W	6	55	13	27	0	0	0	36	0	2
	NW	14	9	24	30	0	15	0	64	0	0
	WIND SPEEDS (% OF TIME)										
	CALM	3	0	0	0	0	0	0	0	0	1
	<4 M/S	50	10	5	26	3	38	9	3	0	40
	>=4 M/S	47	90	95	74	97	62	91	97	100	59
	TEMP (C)	2	7	5	4	6	6	3	4	12	11

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

APRIL, 1978

10/17/78
AIRQUAL

HI-VOL MONTHLY SUMMATION

	<=MEAN<=	RANGE
ISP*	8	0 TO 49
AL	207	56 TO 491
AS	1	0 TO 5
B	****	**** TO ****
BE	0	0 TO 0
BEN SOL	****	**** TO ****
BI	1	0 TO 1
CA	****	**** TO ****
CD	0	0 TO 1
CL	****	**** TO ****
CO	0	0 TO 0
CR	4	3 TO 5
CU	88	52 TO 164
F	0	0 TO 1
FE	180	53 TO 381
HG	5	3 TO 7
K	140	65 TO 244
MG	93	33 TO 169
MN	7	3 TO 14
MO	0	0 TO 0
NA	****	**** TO ****
NI	3	1 TO 5
PB	9	7 TO 11
SB	1	0 TO 2
SE	1	0 TO 2
SN	****	**** TO ****
SO4	705	480 TO 910
V	2	2 TO 2
ZN	9	2 TO 22

* ISP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
TSP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

MONTHLY DUSTFALL CONCENTRATIONS

SOLUBLE PARTICULATES**	1.4
INSOLUBLE PARTICULATES	0.9
TOTAL PARTICULATES	2.3
	1
	0
** PARTICULATE VALUES	****
ARE IN GRAMS PER SQUARE	0
METER PER 30 DAYS	****
ALL OTHER VALUES ARE IN	0
MILLIGRAMS PER SQUARE	****
METER PER 30 DAYS	0
	****
	0
	0
	1
	****
	0
	0
	18
	21
	2
	0
	****
	1
	0
	0
	0
	****
	****
	0
	4

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.02 MG SO3/100 CM2/DY

NITRATION RATE
0.09 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.01 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.00 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	2	3
NNE	1	0
NE	1	1
ENE	1	2
E	3	13
ESE	2	23
SE	1	9
SSE	1	1
S	1	1
SSW	1	0
SW	1	0
WSW	0	1
W	1	4
WNW	2	10
NW	1	8
NNW	1	3
CALM	0	

AVERAGE TEMPERATURE (C)	4.9
MAXIMUM TEMPERATURE (C)	18.0
MINIMUM TEMPERATURE (C)	-4.4
BAROMETRIC PRESSURE (MB)	910.6
TOTAL PRECIPITATION (MM)	8.13
TOTAL EVAPORATION (MM)	******

Table 10A

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 51N40E34CCDB
ELEVATION: 827 METERS

MAY, 1978

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	2	5	8	11	14	17	20	23	26	29
MONTANA	TSP	14	11	6	4	9	5	6	10	6	14
	AL	****	****	****	137	****	77	****	202	****	356
SUSPENDED SULFATE	AS	****	****	****	0	****	1	****	0	****	1
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	****	****	0	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	****	****	1	****	2	****	3	****	2
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	****	****	0	****	0	****	0	****	0
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	****	****	0	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	****	****	****	3	****	2	****	4	****	3
	CU	****	****	****	194	****	41	****	42	****	305
BERYLLIUM	F	****	****	****	6	****	****	****	1	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	****	****	****	119	****	53	****	151	****	179
	HG	3	****	****	****	0	****	4	****	0	****
	K	49	****	****	****	49	****	37	****	77	****
FEDERAL	MG	74	****	****	****	54	****	44	****	38	****
	MN	5	****	****	****	3	****	3	****	2	****
TOT SUSPENDED PARTICULATE	MO	0	****	****	****	0	****	0	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	2	****	****	****	3	****	3	****	3	****
260 UG/M3 AIR, ONCE/YEAR	PB	3	****	****	****	4	****	4	****	5	****
SECONDARY	SB	1	****	****	****	1	****	0	****	0	****
60 UG/M3 AIR, ANN GEO MEAN	SE	1	****	****	****	0	****	0	****	0	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	379	****	****	****	417	****	****	****	438	****
LEAD	V	1	****	****	****	0	****	0	****	0	****
PENDING	ZN	28	****	****	****	18	****	13	****	17	****
BERYLLIUM		DAILY WIND ROSE (% OF TIME)									
PENDING	N	3	10	58	26	0	83	0	26	0	15
	NE	0	33	0	6	0	13	0	8	0	8
	E	6	39	0	13	16	0	2	55	0	1
	SE	22	12	0	18	64	0	36	0	0	0
	S	47	4	0	17	20	0	50	2	0	0
	SW	8	1	1	12	0	0	1	1	-50	15
	W	1	1	15	6	0	0	10	1	49	30
	NW	11	0	26	8	0	4	0	7	1	31
		WIND SPEEDS (% OF TIME)									
	CALM	0	0	0	0	0	0	0	0	1	1
	<4 M/S	22	39	26	71	3	8	39	28	47	40
	>=4 M/S	78	61	74	29	97	92	61	72	52	59
	TEMP (C)	12	8	10	6	17	9	13	17	12	13

Table 10B

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31A40E34CCC05
ELEVATION: 827 METERS

MAY, 1978

10/17/78
AIRQUAL
PAGE 2 OF 2

HI-VOL MONTHLY SUMMATION	<=MEAN<=	RANGE	MONTHLY DUSTFALL CONCENTRATIONS	
TSP*	8	4 TO 14	SOLUBLE PARTICULATES**	0.6
AL	193	77 TO 356	INSOLUBLE PARTICULATES	0.3
AS	1	0 TO 1	TOTAL PARTICULATES	1.1
B	****	**** TO ****		8
BE	0	0 TO 0		0
BEN SOL	****	**** TO ****	** PARTICULATE VALUES	****
BI	2	1 TO 3	ARE IN GRAMS PER SQUARE	0
CA	****	**** TO ****	METER PER 30 DAYS	****
CD	0	0 TO 0	ALL OTHER VALUES ARE IN	0
CL	****	**** TO ****	MILLIGRAMS PER SQUARE	****
CO	0	0 TO 0	METER PER 30 DAYS	0
CR	3	2 TO 4		****
CU	146	41 TO 305		0
F	2	1 TO 6		0
FE	126	53 TO 179		1
HG	2	0 TO 4		****
K	65	37 TO 99		7
MG	52	38 TO 74		0
MN	3	2 TO 5		17
MO	0	0 TO 0		13
NA	****	**** TO ****		2
NI	3	2 TO 3		0
PB	4	3 TO 5		****
SB	0	0 TO 1		1
SE	0	0 TO 1		0
SN	****	**** TO ****		0
SO4	411	379 TO 438		0
V	1	0 TO 1		****
ZN	19	13 TO 28		****
				0
				3

* TSP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
TSP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.00 MG SO3/100 CM2/DY

NITRATION RATE
0.00 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
**** UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.00 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	3	9
NNE	1	8
NE	1	3
ENE	1	2
E	1	2
ESE	1	4
SE	1	5
SSE	1	4
S	2	4
SSW	3	1
SW	5	2
WSW	3	3
W	2	4
WNW	3	5
NW	2	5
NNW	2	5
CALM	0	

AVERAGE TEMPERATURE (C)	12.1
MAXIMUM TEMPERATURE (C)	31.0
MINIMUM TEMPERATURE (C)	3.2
BAROMETRIC PRESSURE (MB)	911.4
TOTAL PRECIPITATION (MM)	98.04
TOTAL EVAPORATION (MM)	******

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JUNE, 1978

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	1	4	7	10	13	16	20	22	25	28
MONTANA	TSP	5	13	8	14	19	17	****	17	7	18
	AL	****	339	****	203	****	304	****	256	****	230
SUSPENDED SULFATE	AS	****	1	****	1	****	1	****	1	****	3
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	0	****	0	****	0	****	0	****	0
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	2	****	2	****	1	****	2	****	2
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	0	****	0	****	0	****	0	****	0
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	0	****	0	****	0	****	0	****	0
5 UG/M3 AIR, 30-DAY AVG	CR	****	3	****	4	****	3	****	3	****	3
	CU	****	129	****	143	****	143	****	441	****	586
BERYLLIUM	F	****	1	****	1	****	1	****	2	****	1
.01 UG/M3 AIR, 30-DAY AVG	FE	****	241	****	313	****	228	****	259	****	203
	HG	0	****	2	****	1	****	0	****	1	****
	K	40	****	41	****	119	****	46	****	47	****
FEDERAL	MG	27	****	44	****	91	****	25	****	35	****
	MN	1	****	3	****	6	****	1	****	2	****
TOT SUSPENDED PARTICULATE	MO	0	****	0	****	0	****	0	****	0	****
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	2	****	2	****	2	****	2	****	2	****
260 UG/M3 AIR, ONCE/YEAR	PB	3	****	3	****	2	****	2	****	1	****
SECONDARY	SB	0	****	1	****	3	****	1	****	1	****
60 UG/M3 AIR, ANN GEO MEAN	SE	0	****	1	****	1	****	0	****	0	****
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	****	****	475	****	382	****	533	****	348	****
LEAD	V	0	****	0	****	0	****	0	****	0	****
PENDING	ZN	8	****	3	****	3	****	3	****	3	****
BERYLLIUM		DAILY WIND ROSE (% OF TIME)									
PENDING	N	5	3	8	11	1	0	0	1	13	1
	NE	1	22	6	3	1	0	0	8	6	25
	E	1	31	1	0	13	0	0	23	3	25
	SE	1	2	2	0	38	0	28	9	7	42
	S	2	1	8	0	18	0	19	28	1	7
	SW	10	31	36	1	15	7	31	13	12	0
	W	29	6	22	78	12	64	20	15	25	0
	NW	51	5	17	7	1	29	2	3	34	0
		WIND SPEEDS (% OF TIME)									
	CALM	1	1	0	0	0	0	0	1	0	0
	<4 M/S	22	72	97	11	38	1	61	65	58	81
	>=4 M/S	78	27	3	89	62	99	39	34	42	19
	TEMP (C)	9	18	11	14	19	13	13	19	15	22

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JUNE, 1978

HI-VOL MONTHLY SUMMATION

	<=MEAN<=	RANGE
ISP*	13	5 TO 19
AL	266	203 TO 339
AS	1	1 TO 3
B	****	**** TO ****
BE	0	0 TO 0
BEN SOL	****	**** TO ****
BI	2	1 TO 2
CA	****	**** TO ****
CD	0	0 TO 0
CL	****	**** TO ****
CO	0	0 TO 0
CR	3	3 TO 4
CU	288	129 TO 586
F	1	1 TO 2
FE	249	203 TO 313
HG	1	0 TO 2
K	59	40 TO 119
MG	45	25 TO 91
MN	3	1 TO 6
MO	0	0 TO 0
NA	****	**** TO ****
NI	2	2 TO 2
PB	2	1 TO 3
SB	1	0 TO 3
SE	0	0 TO 1
SN	****	**** TO ****
SO4	434	348 TO 533
V	0	0 TO 0
ZN	4	3 TO 8

* ISP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS

NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT

ISP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

MONTHLY DUSTFALL CONCENTRATIONS

SOLUBLE PARTICULATES**	0.7
INSOLUBLE PARTICULATES	0.7
TOTAL PARTICULATES	1.3
AL	2
AS	0
B	****
BE	0
BEN SOL	****
BI	0
CA	****
CD	0
CL	****
CO	0
CR	1
CU	1
F	****
FE	7
HG	0
K	12
MG	14
MN	1
MO	0
NA	****
NI	1
PB	0
SB	0
SE	0
SN	****
SO4	****
V	0
ZN	1

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

DUSTFALL STANDARDS

MONTANA

TOTAL SETTLEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.01 MG SO3/100 CM2/DY

NITRATION RATE
0.00 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.01 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.05 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	3	3
NNE	2	2
NE	2	2
ENE	2	1
E	2	1
ESE	3	2
SE	3	4
SSE	3	2
S	2	2
SSW	4	1
SW	5	3
WSW	4	3
W	4	8
WNW	4	9
NW	4	4
NNW	2	3
CALM	0	

AVERAGE TEMPERATURE (C)	16.5
MAXIMUM TEMPERATURE (C)	28.1
MINIMUM TEMPERATURE (C)	4.2
BAROMETRIC PRESSURE (MB)	913.4
TOTAL PRECIPITATION (MM)	99.06
TOTAL EVAPORATION (MM)	******

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JULY, 1978

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	1	4	7	10	13	19	22	25	28	31
MONTANA	TSP	22	9	17	24	15	7	14	32	20	13
	AL	****	101	****	444	****	****	185	****	331	****
SUSPENDED SULFATE	AS	****	2	****	4	****	****	1	****	0	****
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	****	0	****	0	****	****	0	****	0	****
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	****	2	****	2	****	****	1	****	0	****
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	****	0	****	0	****	****	0	****	0	****
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	****	0	****	0	****	****	0	****	0	****
5 UG/M3 AIR, 30-DAY AVG	CR	****	4	****	4	****	****	2	****	1	****
	CU	****	129	****	129	****	****	217	****	76	****
BERYLLIUM	F	****	1	****	1	****	****	1	****	2	****
.01 UG/M3 AIR, 30-DAY AVG	FE	****	397	****	397	****	****	182	****	287	****
	HG	6	****	4	****	3	0	****	1	****	0
	K	196	****	169	****	89	44	****	194	****	68
FEDERAL	MG	89	****	116	****	53	32	****	140	****	46
	MN	7	****	7	****	4	3	****	9	****	3
TOT SUSPENDED PARTICULATE	MO	0	****	0	****	0	0	****	0	****	0
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	3	****	2	****	3	0	****	0	****	0
260 UG/M3 AIR, ONCE/YEAR	PB	4	****	3	****	0	2	****	7	****	5
SECONDARY	SB	1	****	1	****	1	0	****	1	****	0
60 UG/M3 AIR, ANN GEO MEAN	SE	1	****	1	****	0	0	****	0	****	0
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	****	****	****	****	****
	SO4	818	****	486	****	978	1034	****	841	****	976
LEAD	V	0	****	1	****	1	0	****	0	****	0
PENDING	ZN	20	****	20	****	31	0	****	0	****	0
BERYLLIUM	DAILY WIND ROSE (% OF TIME)										
PENDING	N	0	0	0	0	0	0	0	50	24	21
	NE	0	0	0	0	0	0	0	16	22	1
	E	0	0	0	0	0	0	0	0	3	2
	SE	0	0	0	0	0	0	0	0	0	1
	S	0	0	0	0	0	0	0	0	0	1
	SW	0	0	0	0	0	0	0	0	0	3
	W	0	0	0	0	0	0	0	4	9	37
	NA	0	0	0	0	0	0	0	30	42	34
	WIND SPEEDS (% OF TIME)										
	CALM	0	0	0	0	0	0	0	0	0	0
	<4 M/S	0	0	0	0	0	0	0	47	22	93
	>=4 M/S	0	0	0	0	0	0	0	53	78	7
	TEMP (C)	0	0	0	0	0	0	0	24	18	17

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

JULY, 1978

10/17/78
AIRQUAL

HI-VOL MONTHLY SUMMATION

	<=MEAN<=	RANGE
TSP*	16	7 TO 32
AL	265	101 TO 440
AS	2	0 TO 4
B	****	**** TO ****
BE	0	0 TO 0
BEN SOL	****	**** TO ****
BI	1	0 TO 2
CA	****	**** TO ****
CD	0	0 TO 0
CL	****	**** TO ****
CO	0	0 TO 0
CR	3	1 TO 4
CU	138	76 TO 217
F	1	1 TO 2
FE	316	182 TO 397
HG	2	0 TO 6
K	127	44 TO 196
MG	79	32 TO 140
MN	5	3 TO 9
MO	0	0 TO 0
NA	****	**** TO ****
NI	1	0 TO 3
PB	4	0 TO 7
SB	0	0 TO 1
SE	1	0 TO 1
SN	****	**** TO ****
SO4	856	486 TO 1034
V	0	0 TO 1
ZN	12	0 TO 31

* TSP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
ISP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

MONTHLY DUSTFALL CONCENTRATIONS

SOLUBLE PARTICULATES**	****
INSOLUBLE PARTICULATES	****
TOTAL PARTICULATES	****

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

**** (printed repeatedly down the column)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.08 MG SO3/100 CM2/DY

NITRATION RATE
0.00 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.00 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.00 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	5	5
NNE	5	2
NE	3	1
ENE	3	0
E	3	0
ESE	1	1
SE	1	5
SSE	1	1
S	1	1
SSW	2	1
SW	3	1
WSW	5	2
W	6	6
WNW	4	11
NW	5	6
NNW	3	5
CALM	0	

AVERAGE TEMPERATURE (C)	21.0
MAXIMUM TEMPERATURE (C)	33.1
MINIMUM TEMPERATURE (C)	10.5
BAROMETRIC PRESSURE (MB)	914.0
TOTAL PRECIPITATION (MM)	28.19
TOTAL EVAPORATION (MM)	******

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCDB
ELEVATION: 827 METERS

AUGUST, 1978

10/17/78
AIRQUAL
PAGE 1 OF 2

TOTAL SUSPENDED PARTICULATES ARE IN MICROGRAMS PER CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER CUBIC METER
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT

ALL VALUES ARE REFERENCED TO STANDARD CONDITIONS
(1013.2 MILLIBARS AND 25 DEGREES CENTIGRADE)

AIR QUALITY STANDARDS	DAY	3	6	9	12	15	18	21	24	27	30
MONTANA	TSP	14	12	21	36	16	10	12	26	17	29
	AL	270	****	188	****	185	****	140	****	291	****
SUSPENDED SULFATE	AS	0	****	0	****	0	****	0	****	0	****
4 UG/M3 AIR, ANN AVG	B	****	****	****	****	****	****	****	****	****	****
12 UG/M3 AIR, 1% TIME	BE	0	****	0	****	0	****	0	****	0	****
	BEN SOL	****	****	****	****	****	****	****	****	****	****
TOT SUSPENDED PARTICULATE	BI	0	****	0	****	0	****	1	****	1	****
75 UG/M3 AIR, ANN GEO MEAN	CA	****	****	****	****	****	****	****	****	****	****
200 UG/M3 AIR, 1% OF TIME	CD	0	****	0	****	0	****	0	****	0	****
	CL	****	****	****	****	****	****	****	****	****	****
LEAD	CO	0	****	0	****	0	****	0	****	0	****
5 UG/M3 AIR, 30-DAY AVG	CR	1	****	1	****	3	****	2	****	2	****
	CU	103	****	220	****	188	****	60	****	221	****
BERYLLIUM	F	1	****	2	****	2	****	1	****	2	****
.01 UG/M3 AIR, 30-DAY AVG	FE	256	****	185	****	197	****	137	****	273	****
	HG	****	1	****	1	****	16	****	****	****	19
	K	****	156	****	241	****	118	****	****	****	271
FEDERAL	MG	****	136	****	182	****	38	****	****	****	149
	MN	****	10	****	15	****	2	****	****	****	6
TOT SUSPENDED PARTICULATE	MO	****	0	****	0	****	0	****	****	****	0
PRIMARY	NA	****	****	****	****	****	****	****	****	****	****
75 UG/M3 AIR, ANN GEO MEAN	NI	****	0	****	0	****	6	****	****	****	3
260 UG/M3 AIR, ONCE/YEAR	PB	****	7	****	7	****	6	****	****	****	6
SECONDARY	SB	****	1	****	1	****	0	****	****	****	2
60 UG/M3 AIR, ANN GEO MEAN	SE	****	1	****	1	****	****	****	****	****	0
150 UG/M3 AIR, ONCE/YEAR	SN	****	****	****	****	****	1	****	****	****	****
	SO4	****	716	****	494	****	254	****	****	****	566
LEAD	V	****	0	****	0	****	0	****	****	****	0
PENDING	ZN	****	0	****	0	****	98	****	****	****	27
BERYLLIUM	DAILY WIND ROSE (% OF TIME)										
PENDING	N	9	2	0	25	0	0	9	12	48	0
	NE	0	0	0	22	0	0	32	43	31	3
	E	0	3	1	6	0	0	7	15	4	31
	SE	10	8	20	3	20	0	0	13	4	64
	S	12	5	24	14	1	8	1	13	2	2
	SW	10	27	53	15	9	15	6	6	0	0
	W	34	36	3	0	62	48	28	0	11	0
	NW	24	18	0	6	8	30	17	0	0	0
	WIND SPEEDS (% OF TIME)										
	CALM	1	0	0	3	0	0	1	1	0	0
	<4 M/S	89	58	76	95	35	34	68	82	98	28
	>=4 M/S	10	42	24	1	65	66	31	17	2	72
	TEMP (C)	15	24	24	26	19	14	16	21	14	19

Table 13B

MONTANA ENERGY AND MHD RESEARCH AND DEVELOPMENT INSTITUTE, INC.
ENVIRONMENTAL ENGINEERING DIVISION - TASK 2
GLASGOW AFB STUDY - AIR QUALITY DATA

STATION: GLASGOW AIR FORCE BASE
LOCATION: 31N40E34CCD
ELEVATION: 827 METERS

10/17/78
AIRQUAL
PAGE 2 OF 2

AUGUST, 1978

HI-VOL MONTHLY SUMMATION / MONTHLY DUSTFALL CONCENTRATIONS

	<=MEAN<=	RANGE	MONTHLY DUSTFALL CONCENTRATIONS
			SOLUBLE PARTICULATES** 0.9
			INSOLUBLE PARTICULATES 0.4
ISP*	18	10 TO 36	TOTAL PARTICULATES 1.3
AL	215	140 TO 291	2
AS	0	0 TO 0	0
B	****	**** TO ****	****
BE	0	0 TO 0	0
BEN SOL	****	**** TO ****	****
BI	1	0 TO 1	0
CA	****	**** TO ****	****
CD	0	0 TO 0	0
CL	****	**** TO ****	****
CO	0	0 TO 0	0
CR	2	1 TO 5	1
CU	158	60 TO 221	3
F	1	1 TO 2	****
FE	209	137 TO 273	32
HG	9	1 TO 19	0
K	196	118 TO 271	13
MG	126	38 TO 182	6
MN	8	2 TO 15	2
MO	0	0 TO 0	0
NA	****	**** TO ****	****
NI	2	0 TO 6	1
PB	7	6 TO 7	0
SB	1	0 TO 2	0
SE	0	0 TO 1	0
SN	1	1 TO 1	****
SO4	508	254 TO 718	****
V	0	0 TO 0	48
ZN	51	0 TO 98	3

** PARTICULATE VALUES ARE IN GRAMS PER SQUARE METER PER 30 DAYS
ALL OTHER VALUES ARE IN MILLIGRAMS PER SQUARE METER PER 30 DAYS

* ISP AVERAGE IS GEOMETRIC MEAN
ALL OTHER AVERAGES ARE ARITHMETIC MEANS
NEGATIVE NUMBER DENOTES <= DETECTABLE LIMIT
LOWER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO ZERO
HIGHER MEAN OBTAINED BY EQUATING DAILY NEGATIVE NUMBERS TO THE ABSOLUTE VALUE OF THE DETECTABLE LIMIT
ISP VALUES ARE IN MICROGRAMS PER STANDARD CUBIC METER
ALL OTHER VALUES ARE IN NANOGRAMS PER STANDARD CUBIC METER
(1013.2 MB AND 25 C)

DUSTFALL STANDARDS

MONTANA

TOTAL SETTEABLE PARTICULATES
15 TONS/SQUARE MILE/30 DAYS
(5.25 GM/M2/30 DAYS)
3 MONTH AVG - RESIDENTIAL AREAS

30 TONS/SQUARE MILE/30 DAYS
(10.5 GM/M2/30 DAYS)
3 MONTH AVG - INDUSTRIAL AREAS

FEDERAL

NONE

MONTHLY STATIC SAMPLES

SULFATION RATE
0.06 MG SO3/100 CM2/DY

NITRATION RATE
0.00 UG NO2/CM2/DAY

FLUORIDATION RATE
(CALCIUM FORMATE)
0.00 UG F/CM2/30 DAYS

FLUORIDATION RATE
(SODIUM FORMATE)
0.00 UG F/CM2/30 DAYS

STATIC STANDARDS

MONTANA

SULFATES
0.25 MG SO3/100 CM2/DY
MAX ANNUAL AVERAGE
0.50 MG SO3/100 CM2/DY
MAX MONTHLY AVERAGE

FLUORIDES
0.3 UG F/CM2/30 DAYS

NITRATES
NONE

FEDERAL

NONE

MONTHLY METEOROLOGICAL DATA

WIND ROSE (% OF TIME)

	<4 M/S	>=4 M/S
N	4	5
NNE	4	1
NE	2	2
ENE	2	1
E	2	1
ESE	3	4
SE	3	2
SSE	2	1
S	3	2
SSW	5	1
SW	4	2
WSW	3	3
W	3	7
WNW	3	11
NW	4	7
NNW	2	4
CALM	0	

AVERAGE TEMPERATURE (C)	19.4
MAXIMUM TEMPERATURE (C)	33.4
MINIMUM TEMPERATURE (C)	4.0
BAROMETRIC PRESSURE (MB)	913.9
TOTAL PRECIPITATION (MM)	3.30
TOTAL EVAPORATION (MM)	******

A high-volume air sampler consists of a vacuum motor which draws ambient air through a filter at a known rate. It measures the total amount of suspended dust in the air. Four parameters have federal and/or Montana state standards. These are total particulates, beryllium, lead, and sulfate. In no case did any measured value of any parameter exceed the appropriate standard and usually was considerably less than the standard.

The dustfall collector is simply an inert plastic jar, partially filled with water or a water/alcohol mixture, which collects the settleable particulates in the air. It is set out for a month at a time. In one instance, January 1978, the amount of dust collected exceeded the standard for residential areas. The standard is based upon a three-month average; however, no three-month averages of the measured values exceeded the standard.

Static samplers are media which are treated chemically to react with a given pollutant. They are exposed to the ambient air for a month and then analyzed. In no case did the measured value of a sampler exceed the appropriate standard; values, in fact, averaged a factor of ten below the standards.